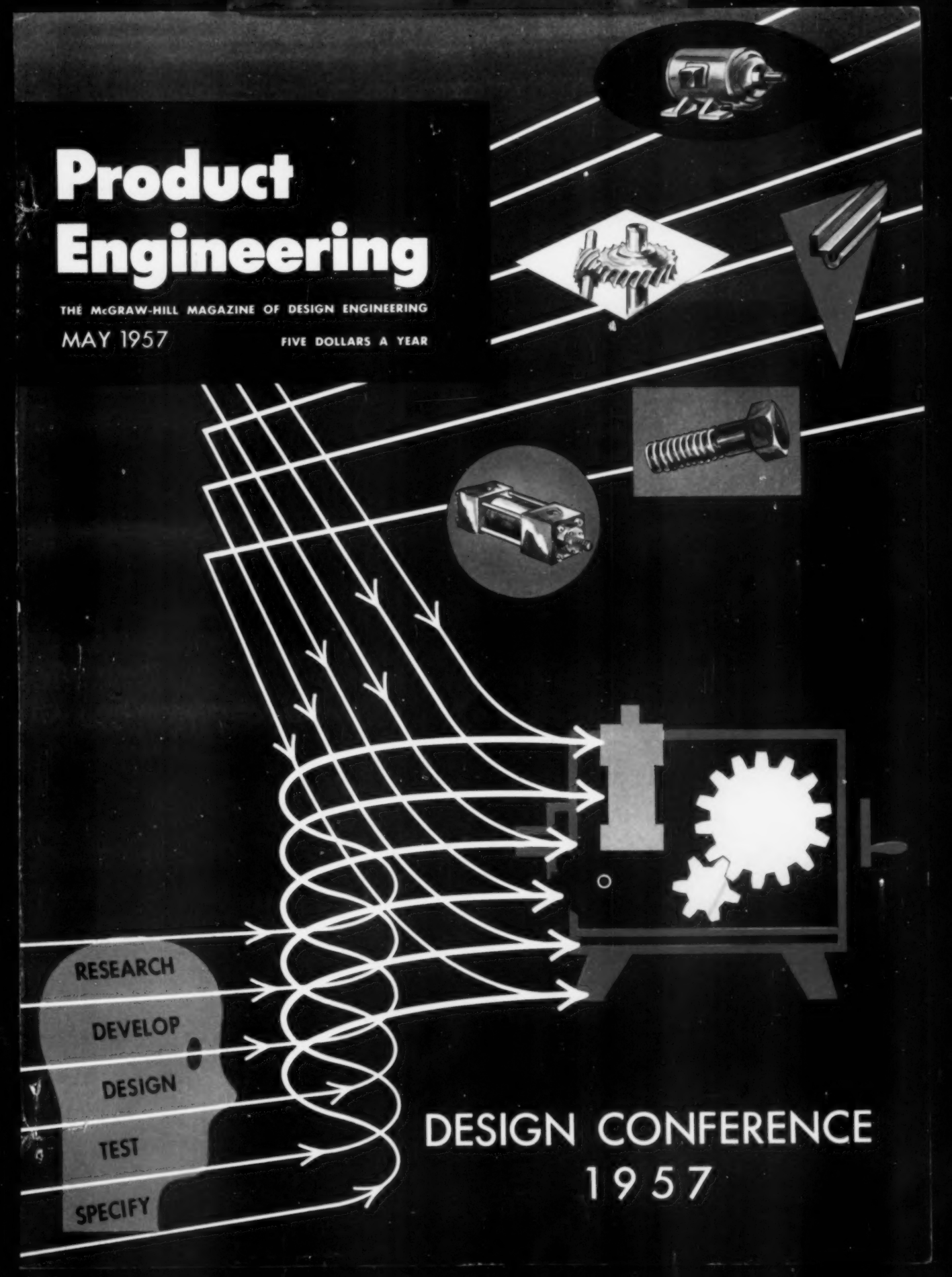
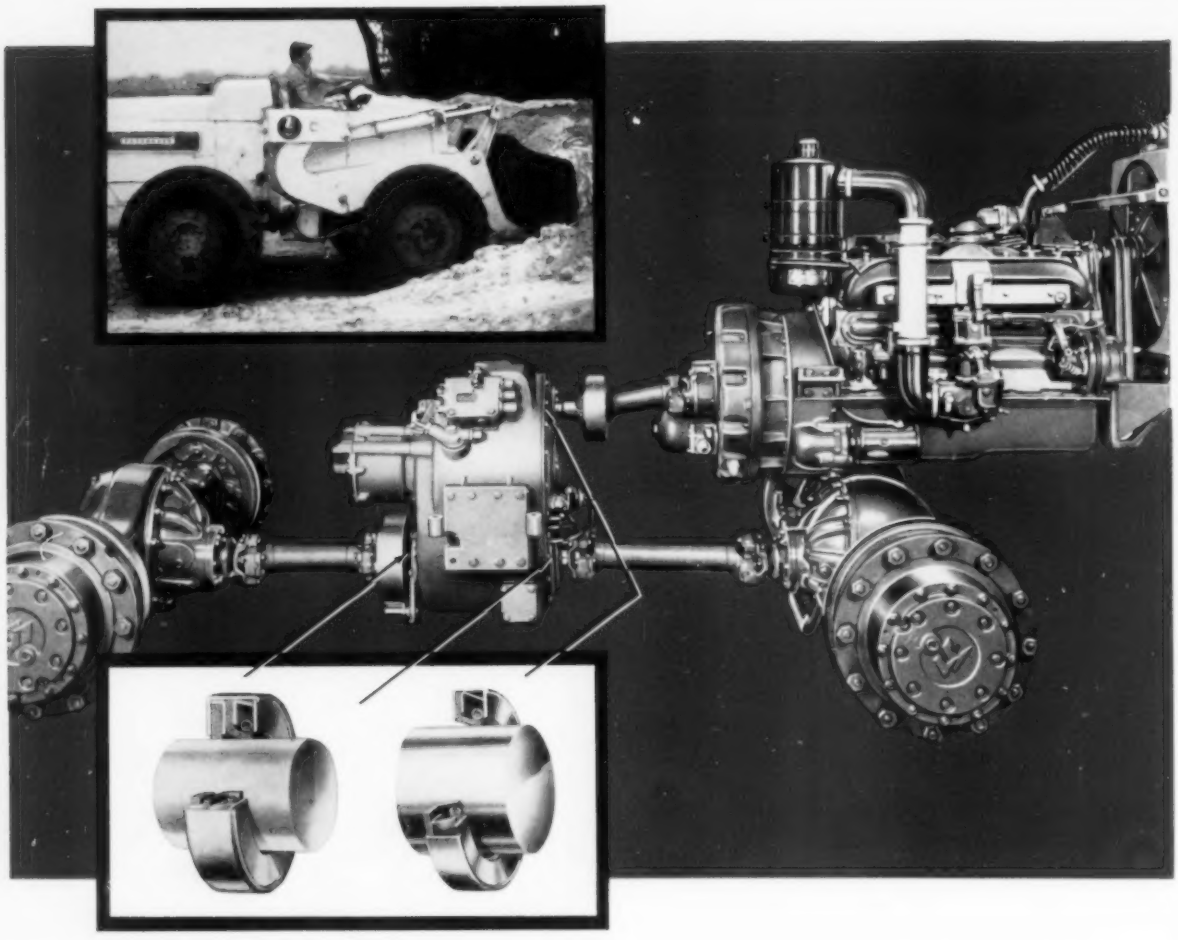
Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

MAY 1957 FIVE DOLLARS A YEAR



DESIGN CONFERENCE 1957



Keeps a workhorse working!

C/R lifeguards the power-shifted transmission in the big Hough "Payloader"

The new Hough Model HH "Payloader" is a big, tough tractor-shovel that wades through hard, rugged work day after day without flinching. Its power-shifted transmission makes it one of the fastest-maneuvering, easiest-handling tractor-shovels on rubber. To keep the transmission humming, two shafts must be protected: an input shaft turning up to 2,200 r.p.m., and an output shaft operating at speeds up to 3,000 r.p.m. All vital parts of the transmission are pressure-lubricated—the SAE 10 HD oil *must* be retained; dirt and grit *must* be excluded. C/R Type P and F Oil Seals with the Conpor K-400 sealing elements . . . specified by Hough engineers . . . have been performing with complete dependability well beyond the required 2,000-hour service life.

If you have similar problems involving lubricant retention or dirt exclusion, C/R Oil Seal engineers can help you. They'll select the correct seal for your application or gladly cooperate with you on special designs.

See us at the Design Engineering Show,

Booth 616-618

OIL SEAL C/R DIVISION

CHICAGO RAWHIDE

CHICAGO RAWHIDE MANUFACTURING COMPANY
1237 Elston Avenue Chicago 22, Illinois

Offices in 55 principal cities. See your telephone book.

In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Hamilton, Ontario

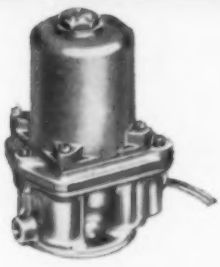
Export Sales: Geon International Corp., Great Neck, New York.

OTHER C/R PRODUCTS: Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears

NEW Ross Starline air control valve series

NEW long life

WHITE STAR
SPOOL SOLENOID



GOLD STAR
OIL-IMMERSED SOLENOID

BLUE STAR MV

BLUE STAR TD

BLUE STAR WV

NEW match any head to any valve body!

STRAIGHTWAY NORMALLY OPEN

STRAIGHTWAY NORMALLY CLOSED

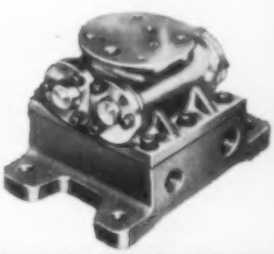
3 WAY NORMALLY OPEN

3 WAY NORMALLY CLOSED

3 WAY NORMALLY OPEN

3 WAY NORMALLY CLOSED

4 WAY



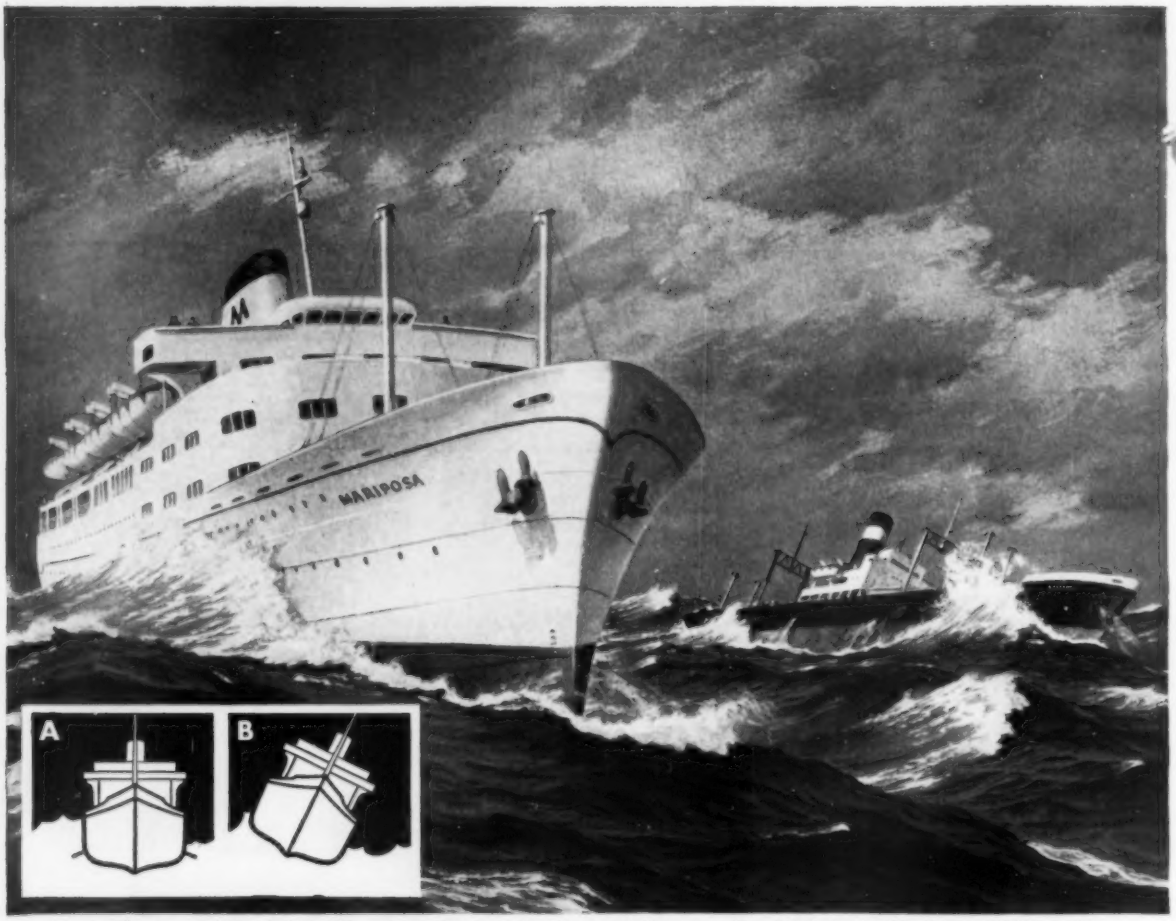
Tests indicate a trouble-free life of over 25 million cycles for valves with the spool solenoid pilot section, and *more than 40 million for all other Starline* valves shown.

Heads and bodies are completely and instantly interchangeable. Sizes from ¼" to 1¼". Even *more* Starline models coming later. Write for Starline data file.

A Galaxy of New Air-Control Stars Are Coming Your Way From

Ross OPERATING VALVE COMPANY

114 EAST GOLDEN GATE AVENUE • DETROIT 3, MICHIGAN



In rough sea, stabilized ship (A) extends fins to halt roll. It holds course without reducing speed. Unstabilized ship (B) rolls and is forced to cut speed. First two commercial installations of the Gyrofin are on the Matson Lines, Mariposa and Monterey. Randolph Sevier, President of Matson Lines, says, "In addition to added passenger comfort, we expect to realize savings in fuel and time because the ships will be able to maintain course and speed in heavy weather."

Imagine – smoothing out the ocean!

When the sea plays rough, it shows no respect for a ship.

But the days of rock 'n' roll – seagoing variety – are numbered.

Credit this to an amazing device. It's Sperry's new Gyrofin® Ship Stabilizer, almost human in the way it out-thinks and outwits rough weather.

The Gyrofin takes the pulse of the turbulent sea . . . immediately sets underwater stabilizing fins to work producing "lift" which counteracts the action of the waves.

Two fins, only 14 feet long, help to hold a 20,000-ton ship smooth and steady on her course. They eliminate up to 90% of roll that might shift cargo, slow speed, spill soup or otherwise spoil a voyage.

Opposing a raging sea puts a terrific strain on these fins, of course. The 6,000 foot-tons of "lift" they deliver may change direction every two seconds! So the entire assembly has to be able to take it.

That's why Sperry chose strong, corrosion-resisting nickel-copper alloys for so many vital parts. The fin flap "hinge pins"—fourteen feet long but only four inches in diameter – are "K" Monel* age-hardenable nickel-copper alloy. Spacer ring "washers" . . . Monel* nickel-copper alloy. Fin control surfaces . . . welded Monel overlay. These nickel-copper alloy parts are designed to take all the punishment that battering tons of sea water can offer. *And they do!*

• • •

If you have a problem finding a metal to withstand destructive service, consider the Inco Nickel Alloys. Their many useful properties and wide-spread applications are described in a helpful booklet: *Standard Alloys for Special Problems.* Why not write for a copy today?

*Reg. U. S. Pat. Off.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK

INTERNATIONAL NICKEL
Nickel Alloys Perform Better, Longer

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

MAY 1957 Vol. 28, No. 5

SPECIAL REPORT

Toward a New Design Philosophy—135...
Design for Automatic Manufacture...L. DeKanski, A. Bonanno, M. Kalb
Automation—Who Does It...Wilson H. Hannahs
How Automatic Assembly Affects Product Design
Committee "Designs" Profit Into Price...E. J. Tangerman
Multiple Committees Consider Customer Acceptance
Preproduction Engineering—by Committee...Phillip S. Sussman
"Blast—then Refine . . ."
Value Control—Next Step for Value Analysis...L. D. Miles

Tilt-Type Mercury Switches—159... Warner E. Johnson
Mechanical and electrical characteristics, mounting methods, service effects.

Single-Component Epoxy Adhesive—164... Bernard Gould
Strength and curing data for paste adhesive requiring no hardener.

Hydraulic Control Valves-IV—167... John J. Pippenger
Spool design in four-way valves and typical circuit applications, with ports blocked, open, throttled or in neutral positions.

Design Features in New Products—174...
Bus floor part of frame; laminated press frame; pontoon-and-track vehicle; shock tester; free-piston rock drill; cooking temperature control; escapement feeds parts; glass-lined pumps; spring-pin assembled valve.

Mass Moments of Inertia for Irregular Parts—184... D. M. Ellett
Three pendulum systems for determining precise values with known error.

Program of 1957 Design Conference—188...
Speakers at sessions on materials, electrical, and mechanical components.

Design of Chrome-Plated Diecastings—190... Dan H. Robinson
Suggestions on base materials, section thickness, surface, fillets and corners, parting lines, lettering and racking.

Tolerances for Gear Measurements—194... G. W. Michalec
Methods and tables for converting AGMA designations of backlash and precision to equivalent tolerances for over-pin specifications.

MECHANISM SPREAD

Latch, Toggle and Trigger Devices—200... Sigmund Rappaport
Sixteen basic latching and quick-release mechanisms.

Short-cut for Powers of Numbers—202... Will J. Worley
Precise answers without reference to tables or slide rules.

REFERENCE BOOK SHEET

Machining Tolerances—219...
Practical tolerances for various machining operations.

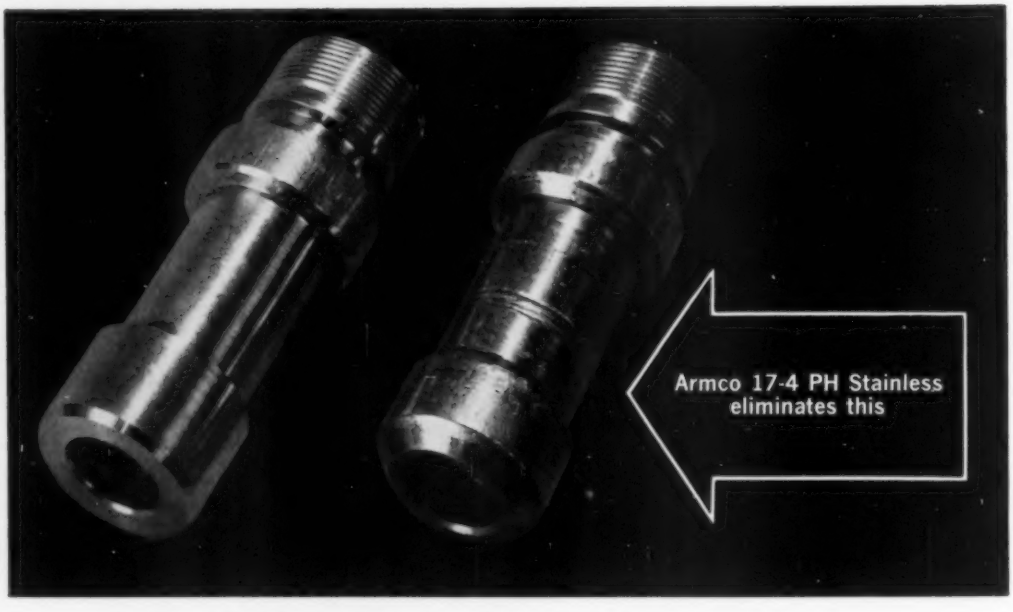
Resistance of Parallel Circuits—221... Leo Fiderer
Graphical solutions accurate to two significant figures from alignment chart.

Flow Rate of Liquid Through Orifices—223... Howell C. Lowe
Theoretical rates from 1 to 80 gpm and pressures from 10 to 100 psi.

DEPARTMENTS

Interesting to Note	5	Catalogs and Bulletins	326
Developments to Watch	9	Sans, Souci	352
Design Perspectives	123	Readers' Letters	378
Editorials	133, 216	Engineering Abstracts	398
Technical News	207	New Books	450
New Components, Materials	232	Press Previews	505

Designer Solves "Fishing" Problem with Armco 17-4PH Stainless Steel



Unusual combination properties of special Armco Stainless assures satisfactory performance of vital part.

This problem was not landing a "big one" but designing a valve "fishing neck" to give unfailing performance in rugged underground oil well service. Formerly made of a high alloy nonferrous metal, the part couldn't withstand the battering and high stresses when grappling tools "fished" the valve to the surface.

Now made of Armco 17-4 PH Stainless, the part has the required corrosion resistance, high hardness and strength to assure good "fishing." And it eliminates costly delays in well operation.

Solution to Many Design Problems

This vital part is typical of how Armco 17-4 PH is being specified to improve product durability and performance in a wide variety of applications. Wherever parts are subject to corrosion in combination with high stresses, wear, abrasion or temperatures as high as 900 F, this special stainless steel gives you unusual opportunities to improve your products.

Here's what 17-4 PH Stainless offers:

- **Typical ultimate tensile strengths up to 200,000 psi**
- **Rockwell hardness of C43 in the fully hardened condition**
- **High mechanical properties at temperatures up to 900 F**
- **No distortion and scale-free heat treatment at only 900 F**
- **Corrosion resistance generally comparable to Type 302**
- **Good machining and fabricating properties**

Armco 17-4 PH Stainless is produced in bars, wire and billets. A companion grade, Armco 17-7 PH, is available in those forms as well as sheets, strip and plate. For full information on the properties of these special Armco Stainless Steels, write us at the address below.

ARMCO STEEL CORPORATION

1357 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

ALBERT HAUPTLI *publisher*

GEORGE F NORDENHOLT *editor*
ELMER J TANGERMAN *executive editor*
ROBERT W CARSON *managing editor*
NORMA J VAN NESS *asst to managing editor*

ROBERT E ABBOTT *associate editor*
JAMES R MC DERMOTT *associate editor*
NICHOLAS CHIRONIS *associate editor*
RICHARD M KOFF *associate editor*
HENRY E COOK, JR *associate editor*
FORK R PARK *associate editor*

JOHN KOLB *assistant editor*
FELIX GIORDANO *assistant editor*
JOSEPH J KELLEHER *assistant editor*
BENEDICT A. LEERBURGER, JR *assistant editor*
DOUGLAS C GREENWOOD *assistant editor*

RICHARD E ROOMAN *art director*
RICHARD B MARSHALL *art director*
LILLIAN WITHAM *assistant*

JOSEPH KERR *consulting editor*
ROBERT E BRUCKNER *consulting editor*

PAUL N ANDERSON *associate editor (news)*
GEORGE B BRYANT, JR *Washington*
RICHARD A LAWRENCE *European correspondent*
HARRY HOMEWOOD *Detroit*
ROBERT E COCHRAN *Cleveland*
MARGARET RALSTON *San Francisco*
JOHN SHINN *Los Angeles*
MICHAEL J MURPHY *Los Angeles*
CHARLES T DIXON, JR *Atlanta*
KEMP ANDERSON, JR *Dallas*
WILLIAM J COUGHLIN *London*
ROBERT E FARRELL *Paris*
PETER WEAVER *Rio de Janeiro*
GERALD W SCHRODER *Bonn*
DAN KURZMAN *Tokyo*
JOHN H KEARNEY *Mexico City*

STANLEY J ALLING *advertising sales manager*
P F PRITCHARD *manager, market research*
ROBERT C MATTOON, *circulation manager*
C C KANE *reader service manager*
RUSSELL T DOUGLAS *business manager*

THIS MONTH'S COVER

What is the designing process? It is an integration of imagination, ideas and engineering effort with components, materials and services. Our cover this month depicts this synthesis by modern string sculpture, and calls attention to the Design Conference and Show in New York, May 20 to 23, where exhibits of components, materials and services will be joined with current engineering thinking. See you there!

Interesting to Note . . .

For Whom the Roads Toll

How many times have you stood on a street corner waiting for just one of the 255,000 buses now on our roads? If it's any consolation, the problem of waiting for a bus has existed for more than a hundred years. As early as 1833, more than a dozen horseless "steam coaches," carrying as many as twenty paying passengers, operated regularly in London. One such "steam coach" traveled more than 3500 miles in four months, carrying more than 3000 passengers.

Unfortunately, this early bus transportation was strangled by crushing legislation and discriminatory turnpike tolls motivated by influential investors in railroads and coach lines. In 1865, English lawmakers pressed to kill all mechanical vehicles by passing a law restricting the speed of mechanically propelled non-rail vehicles to 4 mph in the country and 2 mph in towns. As late as 1895, J. H. Knight, a designer of gasoline engines, was fined for driving his homemade gas buggy on a public highway without having a man precede him waving a red flag.

The tolls which helped to set bus transportation back half a century are taken today as a matter of course. Tolls to highway users totaled some $300 million in 1956, yet the designers of buses are forever coming up with new ideas in the field. One such idea, a German bus design, is presented on page 174.

The Problem at Almaden

Mercury was one of man's first known elements. Aristotle called it "fluid silver", while Theophrustus, in 315 B. C., reported that it could be obtained from cinnabar by rubbing the ore with vinegar in a mortar. Perhaps the oldest sources of mercury is the Spanish mine, Almaden, in the town of the same name. This mine, first worked by the early Phoenicians, has been responsible for more than a third of the total world's production of mercury.

During the sixteenth century, the mine was controlled by a group of German bankers. However, their management was so atrocious that the workers boycotted the mine and left the town. In 1645, Philip IV gained control and found it necessary to promise the miners fabulous working conditions as an inducement to get them back to Almaden. The men were asked to work only four hours a day; eight days a month; and, seven months a year. He further told them that every male child born within the walled city of Almaden would be forever exempt from military service. These generous terms were

(*Continued on page 7*)

ABP MAY, 1957 **Product Engineering** *A McGRAW-HILL PUBLICATION* Vol. 28, No. 5

PRODUCT ENGINEERING is published monthly with an additional Design Digest Issue in Mid-October, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y. See panel below for directions regarding subscriptions or change in address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St. New York 36, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice-President and Treasurer; John J. Cooke, Secretary Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.

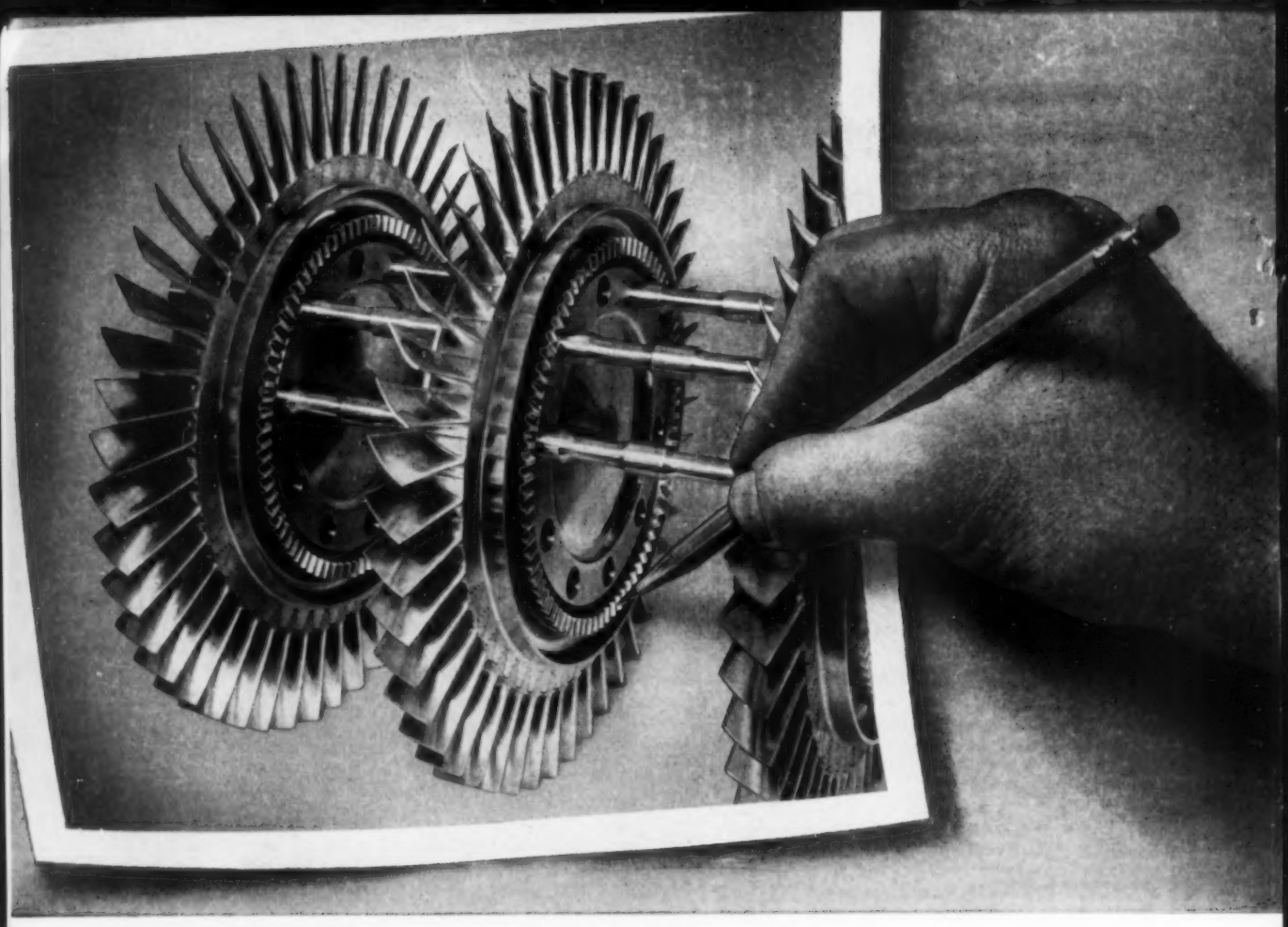
Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. **Position and company connection must be indicated on subscription orders. Send to address shown in box below.**

United States subscription rate for individuals in the field of the publication, $5.00 per year, single copies, one dollar; foreign $25 per year, payable in advance. Second-class mail privileges authorized at Albany, N. Y., U.S.A. © Copyrighted 1957 McGraw-Hill Publishing Company, Inc., all rights reserved.

PRODUCT ENGINEERING articles are indexed in both the **Industrial Arts Index** and the **Engineering Index.** PRODUCT ENGINEERING publishes its own annual index including the Design Digest issue in December issue each year. Copies are obtainable on request to the Editor.

SUBSCRIPTIONS. Send subscription correspondence and change of address to Subscription Manager, PRODUCT ENGINEERING, 330 W. 42nd St., New York 36, N. Y. Subscribers should notify Subscription Manager promptly of any change of address giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Please allow one month for change to become effective.

Postmaster: Please send form 3579 to PRODUCT ENGINEERING, 330 W. 42nd St., New York 36.



Can CURVIC® Couplings lower the cost of your product?

They have done so for scores of manufacturers, by reducing machining time, by saving time in assembly and by permitting more compact design.

CURVIC Couplings are extremely accurate toothed connections which combine the functions of driving, centering and alignment.

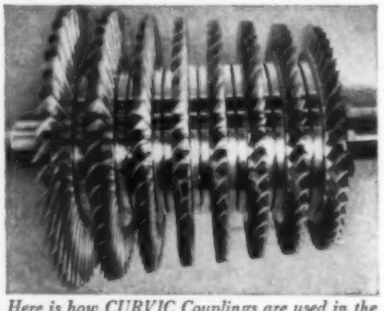
With CURVIC Couplings, complex machine parts can be made in several smaller units and then bolted or otherwise fastened together. Experience has proved that fabrication of many large parts in smaller units has reduced the time spent in machining, simplified final assembly, and reduced over-all manufacturing costs.

And there is no sacrifice of precision —in fact, CURVIC Couplings are so accurate that tolerances in the finished assembly can be held closer than when the part is made by any other means.

CURVIC Couplings are used in such applications as heavy-duty gas turbine rotors like the one shown above, jet engines, crankshafts and camshafts.

In addition to fixed or permanent connections, CURVIC Couplings can be produced in semiuniversal, and in releasing clutch types.

All types of CURVIC Couplings are produced rapidly, economically, and with high precision, on Gleason Cutting and Grinding Machines. If you would like to know more about CURVIC Coupling design or manufacture, the Gleason Works will be glad to consult with you, and to make recommendations about your specific applications. Write for our booklet.



Here is how CURVIC Couplings are used in the production of an 8-stage heavy-duty gas turbine rotor, holding it in perfect alignment under the severe stresses encountered at high speed.

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

Interesting To Note . . . .

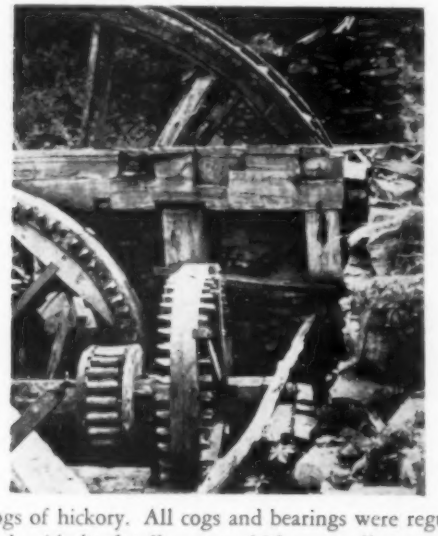
accepted by hordes of men. The town became so well populated that a regiment of soldiers was required to keep pregnant ladies of other cities from invading Almaden for the sole purpose of bearing military-exempt offspring.

The mine at Almaden is still the world's richest source of mercury, producing over 40,000 flasks in 1956 (a flask is 76 lb) compared with 24,000 flasks produced in the United States. About a quarter of all mercury consumed in this country goes into the electrical-apparatus industries. One such product of this industry, the mercury switch, is the subject of an article appearing on page 159.

Gears and Beef Tallow

Driving south on route 92, you pass through the town of Nestorville, W. Va. As in dozens of similar villages in this area, you may notice a structure which was quite familiar to our grandparents—the old waterwheel which supplied power for so many of our forefathers. Through the aid of the Hon. Dayton R. Stemple, West Virginia Legislature, we were able to learn the history of this particular waterwheel.

Built over a hundred years ago, this wheel was used to power both a grist mill and an up-and-down sawmill. Senator Stemple tells us that the wheels were all made of white-oak timbers; the round cogs of dogwood; and the



flat cogs of hickory. All cogs and bearings were regularly greased with beef tallow to which a small amount of rosin was added. This made the cogs and bearings both slick and hard. Jenk Richman, present owner of the mill, remembers that on one occasion when he was out of beef tallow he lubricated the bearings with motor oil and axle grease. Within an hour after he had commenced grinding, the grease had so softened the cogs that they became worn and had to be replaced.

The problems confronting the modern gear designer are not solved simply by shaping a new cog or by lubricating with beef tallow. On page 194, an article gives for the first time, tolerances for over-pin measurements of gears equivalent to the AGMA standards.

Let's Form a Committee

In practically all of our large corporations, decisions evolve through the action of committees. Inner workings of the committee is a subject on which a Harvard sociologist, Robert F. Bales, has spent a great deal of time.

In a report issued by Bales (*Business Week*, March 20, '54) it was stated that the best operating committee contains but five members. Bales further observed that a committee has not one, but two leaders. First it has the "task leader." He keeps the group engaged in work, supplies the ideas and keeps things moving. In this role, many task leaders tend to provoke irritation and injure the unity of the group. The unity is restored and group members kept happy by a second man, the "social leader," who is usually the best-liked member of the committee. When a man becomes chairman of a committee, he must make a decision. Will he be the task leader or the social leader? Bales claims that the majority prefers to have popularity as a "social leader" rather than to risk it by becoming the "task leader."

Although the committee is receiving more and more authority in the field of design, it's still the chief design engineer who must assume responsibility for committee decisions. The design committee is but one of the topics discussed in a special report beginning on page 135. The report includes ideas for design engineers, including procedures involved in arriving at the right decision.

Two Engineers—Revisited

Last month's "Interesting to Note" contained a problem about some ball bearings. As you may remember, two engineers were each given one hundred boxes of ball bearings. Each box contained one hundred balls; each ball weighed one ounce, as did each box. The engineers were further informed that all hundred balls in one box were either 10% heavier or 10% lighter than an ounce, yet their outward appearance was similar to that of the balls in the other boxes. The problem was to identify the box containing the odd-weight balls and specify whether they were heavy or light. A spring scale was to be used and only one reading allowed. This problem is not unsolvable. Both engineers as well as non-engineers have derived the correct solution, which is:

Place on the scale one ball from box one, two from box two, three from box three, and so forth. The scale should read 5050 oz (plus the weight of the container), if the balls weighed one ounce each. However, the scale will read lighter or heavier because of the odd-weight balls. We know that the odd-weight balls weigh either 0.9 oz or 1.1 oz. If the scale reads high, the odd balls each weigh 1.1 oz; if the scale reads low, the balls each weigh 0.9 oz. The difference between 5050 oz (in tenths of an ounce) and the actual scale reading is the number of odd-weight balls, hence identifies the box from which they came. If weight is high by 1.2 oz, for example, the balls in box 12 are overweight.

Another interesting study of numbers is an article, page 202, discussing an ingenious method of computation.

Mallory Gyromet*...

the Alloy for Future Gyroscopes

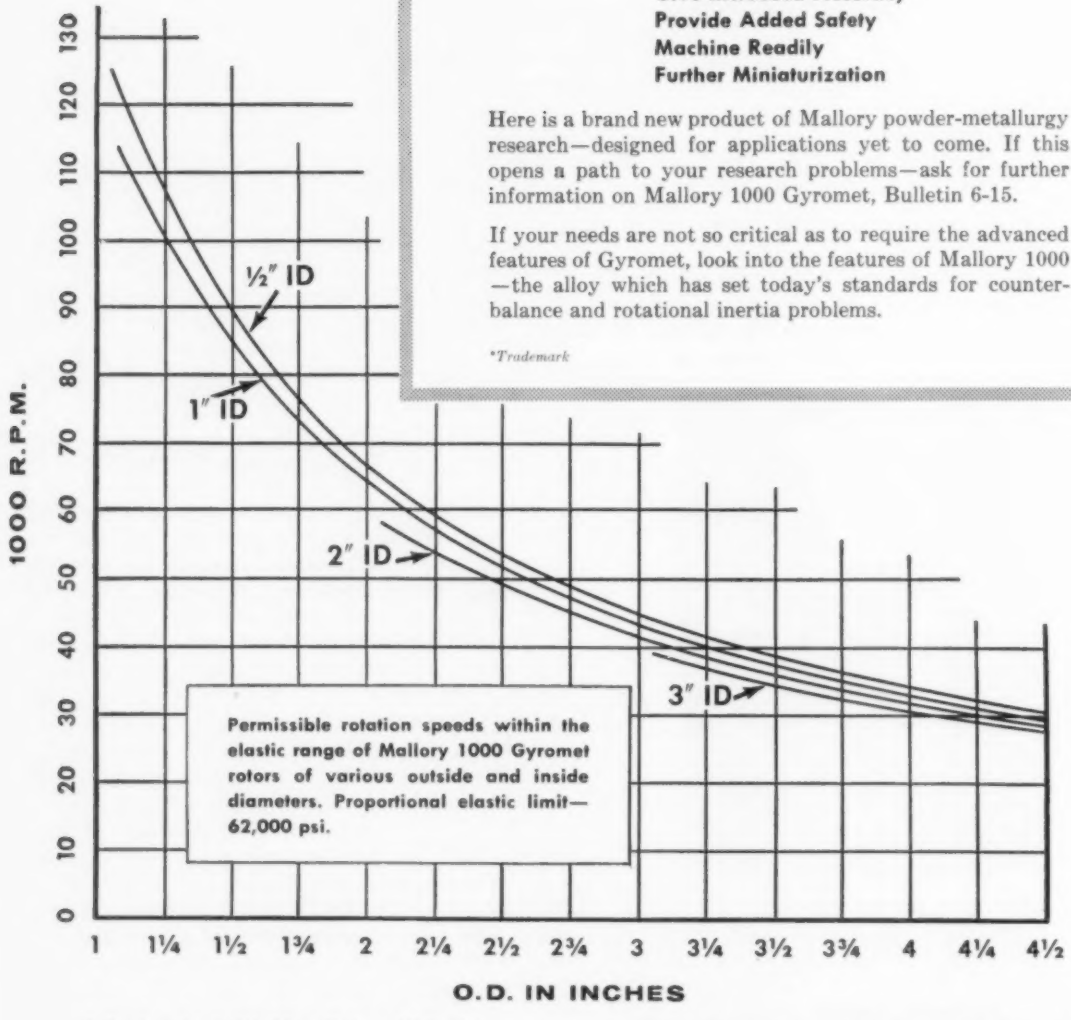
Gyromet—a new gyroscope material having higher tensile strength and greater elastic limit, will:

Rotate at Greater Speeds
Gain Greater Momentum
Give Increased Accuracy
Provide Added Safety
Machine Readily
Further Miniaturization

Here is a brand new product of Mallory powder-metallurgy research—designed for applications yet to come. If this opens a path to your research problems—ask for further information on Mallory 1000 Gyromet, Bulletin 6-15.

If your needs are not so critical as to require the advanced features of Gyromet, look into the features of Mallory 1000 —the alloy which has set today's standards for counter-balance and rotational inertia problems.

*Trademark



In Canada, made and sold by Johnson Matthey and Mallory Ltd., 110 Industry Street, Toronto 15, Ontario

Serving Industry with These Products:

Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical — Contacts • Special Metals • Welding Materials

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

Developments

To Watch

ELECTROPLATING FROM ORGANIC SOLUTIONS . . . .

. . . .has been accomplished with several of the refractory and light metals or their alloys. Beryllium and alloys of magnesium, titanium, or zirconium with aluminum were deposited by plating techniques developed at the National Bureau of Standards, Washington 25, D. C. In the course of this work, improvements were made in the NBS hydride bath process for electrodepositing aluminum. Except for aluminum, the plating of the refractory and light metals is not yet commercially available. The deposition of these metals are so far above hydrogen in the electromotive series that none of them can be deposited from aqueous solutions. With the new process, the best deposits of these metals were obtained from halides, hydrides, borohydrides, and organometallic compounds, dissolved in ether. Electrodeposits of pure titanium and zirconium have not been obtained from organic solutions. However, the following alloys of these metals were deposited from ether solutions: titanium–aluminum (6% Ti), and zirconium-aluminum (45% Zr). Good deposits of magnesium-aluminum were also obtained. Coherent deposits containing 97% beryllium have been produced from an ether solution of beryllium halides and alkyls. To test the commercial possibilities of this process, a model strip plater has been designed by NBS.

TUNGSTEN-SILVER COMPACTS . . . .

. . . .of powdered metal were found to meet the requirements for a material with high X-ray absorption for making small components in the collimating systems of X-ray diffraction units. Developed by an Australian firm, the compacts contain 20 to 25% silver with densities greater than 15 g/ml and are made in two stages. First, a porous tungsten powder compact of controlled density is made by pressing and sintering. This is used as a sponge to absorb the desired amount of silver. The final product is a solid compact which is readily machineable and can be joined to itself and other metals by soft or hard soldering, and silver brazing.

MINNEAPOLIS-HONEYWELL ENGINEERS JOIN THE UAW UNION. . . .

. . . .of the AFL-CIO, after disaffiliating from The Engineers and Scientists of America (ESA), a federation of engineering unions. The Regulator Div. of Minneapolis-Honeywell voted 579 to 116 for the change because of what the president of the engineering union called ESA's emphasis on pure professionalism, and because the federation had "substituted snobbery for mutuality." The United Auto Workers (UAW) has established an Aircraft and Avionics Engineering Council within its National Aircraft Dept. with the intention of unionizing engineers, scientists and technicians in the aviation industry. UAW heads claim that the integration of work-processes under automation makes it difficult to tell the difference between engineers and technicians, and that the UAW could help supply "the muscle" to strengthen the engineer's collective bargaining position.

OPTICAL FINISHING METHODS ARE APPLIED TO METALS . . . .

. . . .with the result that surfaces on stainless steel hemispheres are accurate to 4-6 microinches. Bausch & Lomb Optical Co., Rochester, N. Y., who developed the process, expect further refinements in the process to produce greater precision.

(*Continued on page 10*)

Developments to Watch

Such superfinishing is the result of supersonic aircraft and missile research programs. Bausch & Lomb used methods which were developed for the grinding and polishing of reflectors for the Army and Navy searchlights, and motion picture projectors. According to reports, Bausch & Lomb has a technique which can superfinish hard metals of spherical, parabolic, and elliptical shapes up to 36 in. in diameter.

SELF-OPERATING UNIT RECORDS CRASH EVIDENCE . . . .

. . . .of an aircraft should any of the vulnerable parts begin to malfunction during flight. It records oil failures, engine failures, fuel failure, fire, faulty pressurization, metal fatigue, faulty radio transmitter and many other failures. Both visual and verbal evidence is recorded. The device is considered a valuable aid in determining the reasons for a crash, and for reducing man-hours in inspection time between flights. The crash evidence unit will be ejected automatically from the plane at the time of crash. The unit consists of a number of small heater cartridges wired to micro-switches, pressure switches, and insulator plates in vulnerable parts of the plane. When the first failure occurs maximum wattage flows through the heater cartridge for that part producing maximum discoloration of the plastic coating, thus indicating the source of failure. If more than one failure occurs, the amount of wattage flowing through each cartridge will be the same fraction of the maximum wattage available. The discoloration of plastic around the cartridges decreases showing the sequence of failures. The specially designed ball containing the device is fireproof, shockproof and buoyant. Total weight is 10 lb. Designer is R. H. Orgill, of Western Australia.

LOW COST FUEL INJECTION SYSTEM . . . .

. . . .with a clog-free continuous vortex nozzle, has no moving parts in the injector itself. A pump and valve complete the system. By using a return flow from a continuous vortex nozzle, it is possible to control the full flow into the combustion chamber more efficiently. Jet-Heet, Inc., Englewood, N. J., designers of the injector, say that the cost will be one-third that of other fuel injection systems. The principle of the system is a vortex or whirlpool chamber in the return flow nozzle that is fitted at opposite ends with two concentric orifices of different sizes. Fuel supplied under pressure to the vortex between these openings discharges through both orifices simultaneously during the injection stroke, but only through the larger return orifice at other times. In operation, the return fuel flow, under pressure, is momentarily interrupted by a valve designed to control the injection timing. The return flow prevents valve leakage and inertia problems, which in the conventional fuel injection system can upset fuel metering and injection timing.

BOTH SURFACE AND LIQUID TEMPERATURES . . . .

. . . . can be measured with an electric surface thermometer designed as a resistance thermometer and capable of measuring surface temperatures between —50 C and +200 C with an accuracy of ±0.2 C. The thermometer is made of a watertight nylon measuring head with a welded-on polyvinyl chloride flex. The indicator is a sensitive milliammeter. The thermometer is fed by a flat 4½ volt flashlight battery. Dutch maker is N. V. Alto, Keizersgracht 345 A, Amsterdam-C, Holland.

A WAVE OF MOLTEN SOLDER . . . .

. . . . is the key to the Flowsolder method of soldering printed circuit, developed as an alternative to flat dipping by Fry's Metal Foundries Ltd., Tandem Works, Merton Abbey, London, S.W. 19, England. The wave of solder is formed by forcing the metal up through a special nozzle. The circuit panel remains horizontal

(*Continued on page 12*)

If It's Low Cost Production Runs Of
Extremely Accurate Spiral Bevel Gearing
..IT'S A JOB FOR
G.S. ENGINEERING
Here at G.S., the mass manufacture of Spiral Bevel Gearing has been developed to an *exact* science. We produce them by hundreds or thousands to a degree of UNIFORM accuracy *you never thought possible!* BIG savings accrue for our customers. Rejects and downtime disappear. Products run smoother, quieter, longer. See for yourself. Send drawings or descriptions today!

GEAR
Specialties, Inc.
2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS
SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING
WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

SEND FOR FREE 6-page Small Gearing Guide. It describes 80 types and applications. Contains useful charts . . a valuable aid to anyone interested in Small Gearing. Use company letterhead, please. No obligation, of course. Write today!

41 Years of Specializing in Small Gearing

and moves on a straight line. With this movement, the shape of the solder wave gives the desired angled entry and exit of the circuit board. The moving solder produces a washing action, which when combined with the angled entry of the board prevents the trapping of flux or air. With the constant stream of solder, surface cooling is prevented, allowing a lower working temperature or a shorter contact period. Fine control of the solder level is not necessary, as the height of the wave is easily regulated by the speed of the pump. A special flux, which remains on the circuit panel after it passes over the solder wave, prevents icicles and bridging. Capacity of the bath is 400 lb for the electrically heated machine, and 500 lb for the gas heated unit. Operating temperature is about 480 F. Best speed of the circuit board across the wave is 4 ft. per minute. U. S. representatives are Electrovert Ltd., 489 Fifth Ave., New York, N. Y.

COMPACT, PORTABLE FREQUENCY STANDARD . . . .

. . . . which requires only periodic connection to a commercial power line, is expected to find extensive airborne use and in other applications where a stable but portable frequency stand is required. Developed by the National Bureau of Standards, Washington 25, D. C., the unit incorporates the principle of the latent-heat stabilization method for controlling enclosed space temperatures. Diphenyl is used at its double point (158 F), which is the temperature where it exists as a mixture of a solid and a liquid, and where a temperature stability of a few hundredths of a degree centrigrade was obtained. The frequency standard consists of a transistor crystal-controlled oscillator and a 2-stage transistor buffer-amplifier which are operated continuously from 4 small mercury cells. All the components of the circuit are contained in the diphenyl oven which maintains them at a constant temperature. After the oven temperature has been stabilized at the double point temperature, the unit may be disconnected from the power source which supplied the initial heat, and operated for several hours on temperature without external power connections.

AND IN ADDITION . . . .

. . . . Not far away is production line equipment for the ultrasonic welding of aluminum foil with thicknesses from 0.00016 to 0.007 in., and the welding of dissimilar metals such as aluminum to copper. Aluminum foil with ¼ mil plastic insulation can be welded without damage to the back of the welded metals. . . . Lockheed Aircraft Corp.'s missile systems division has reached a sales volume of $70-million a year; sales increased 700% in the past two years. . . . Westinghouse Electric Corp. is designing a nuclear propulsion plant for a submarine capable of carrying and firing guided missiles. . . . The British Admiralty is working on a nuclear propulsion plant for merchant ships as well as submarines; design of a shore-based prototype is said to be well advanced. . . . A fiberglass liftboat 37.5 ft long, 12.5 ft wide, and molded in one piece, is being tested on a new British 40,000 ton liner. While the cost ($16,800) is greater than metal lifeboats, savings are expected in maintenance costs. Color is molded in; weight is 5½ tons; and capacity is 144 persons. . . . Thomas de la Rue Ltd., London, has developed a paper currency counting machine with "fingers" capacle of counting banknotes at the rate of 16 per second. . . . Developed specifically for making thin-walled or intricate parts with improved resistance to breaking, a new polystyrene compound is available from Union Carbide and Carbon Corp.; less permeable to air, nitrogen, oxygen and water vapor than general purpose polystyrene, it also has shown greater resistance to crazing. . . . Dow Corning Corp., Midland, Mich., reports the development of the toughest, strongest, heat-stable silicone rubber ever made. Some properties of Silastic 916 are: tensile strength, about 1500 psi; tear strength, 200 psi; elongation over 500%; and a hardness of 50 to 60 on the Shore A scale. Useful temperature range is from —130 to over 500 F.

Another Goodyear First:

V-Belts

with the Green Seal

stay matched from factory to drive

The Green Seal signifies true dimensional stability. It means that now when you reach for a matched set of V-belts, you can be sure they're matched – no matter how long they've lain on the shelf. And that means longer life and a minimum of down time.

It used to be that only steel-cable V-belts by Goodyear were length stabilized. But now, through the miracle of Triple-Tempering, they've been joined by all the other Goodyear Industrial V-belts.

Triple-Tempering is the exclusive process wherein synthetic cord is carefully brought to the peak of strength and stability by controlled tempering with Tension, Temperature and Time. And this gives you not only *length* stability in storage, but greater shock- and stretch-resistance on the drive.

In addition to 3-T load-carrying members, the Green Seal also brings you "balanced construction." This means each component of the belt is specifically designed to its job to give you cleaner, smoother, longer running which adds up to maximum, trouble-free horsepower hours at minimum cost.

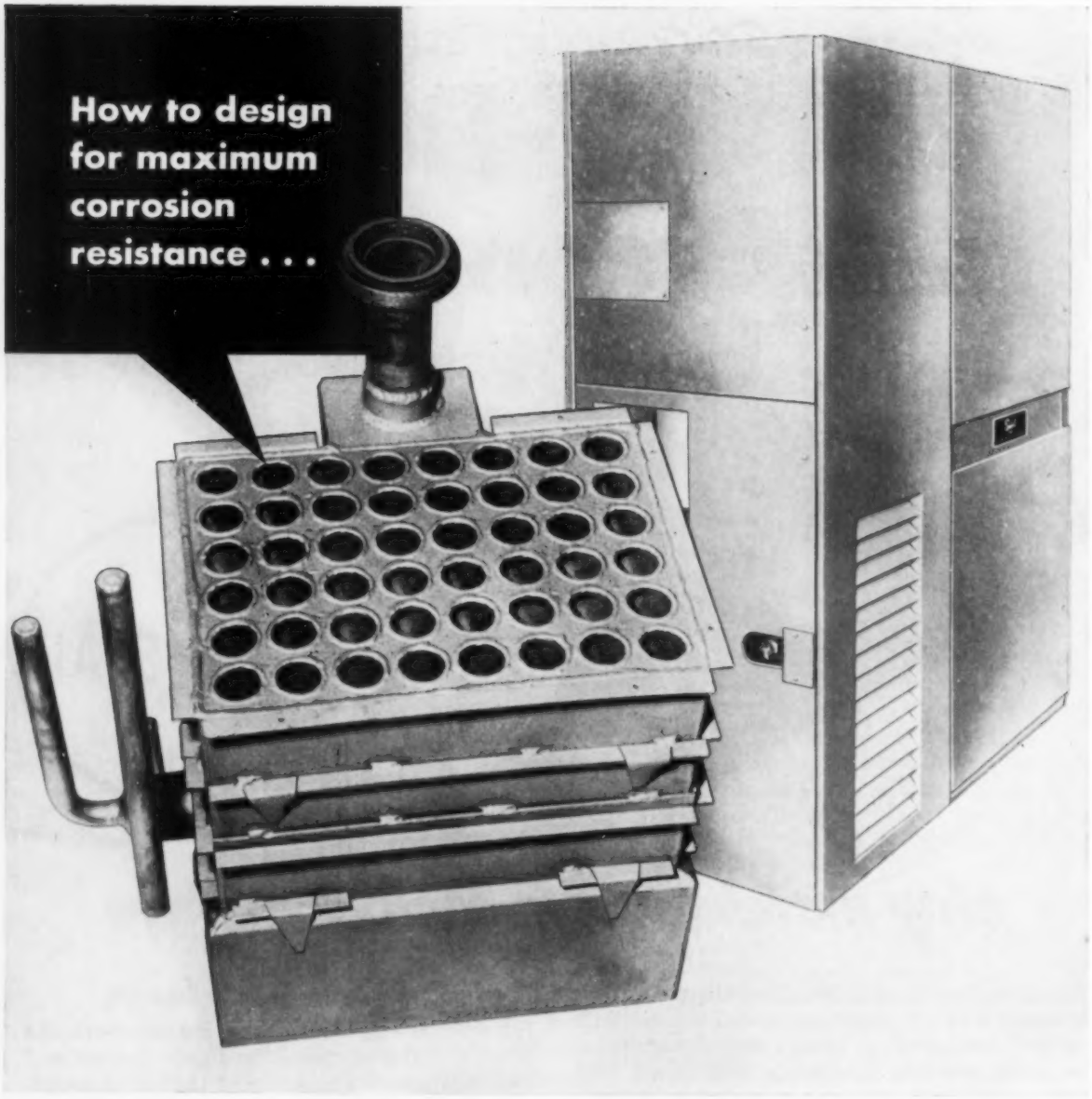
The next time you need V-belts, be sure they're wearing the Green Seal–the mark of a V-belt made with the technical know-how of the world's largest rubber company. They're readily available at your Goodyear Distributor. Or write for details to Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

DIMENSIONALLY STABLE V-BELTS by

GOODYEAR

THE GREATEST NAME IN RUBBER

Green Seal–T. M. The Goodyear Tire & Rubber Company, Akron, Ohio



. . . insist on *Carpenter* Stainless Tubing

Severe corrosion problems were encountered in handling hot flue gas and boiling lithium bromide solution in this generator for a gas-fired year-round air conditioner. The tubes transfer heat from the flue gas to boil a solution of 50% lithium bromide and water surrounding the tubes.

A change to Carpenter Stainless Tubing ended the corrosion problem. Handling this unusual combination of corrodents is just one more example of how Carpenter quality pays off in improved products and lower costs. There's a Carpenter Distributor as near as your telephone. Call him today.

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

"Stress raisers" eliminated by Link-Belt LXS chain design

LXS "FULL-ROUND" DESIGN

"Full-round" pitch holes . . . no sharp corners

"Full-round" pin

"Full-round" bushing

"FULL-ROUND" DESIGN eliminates stress concentration points. Heat treatment of all parts adds even greater strength and extra wear life to selected steels. Accurate control of these processes avoids brittleness, poor wear values and low tensile strengths . . . and assures uniformity.

Large pins, bushings mean ample live bearing area for long life

For long life under severe conveyor and drive conditions, Link-Belt LXS chain provides extra strength, increased wear resistance and wider application flexibility. This fabricated steel roller chain incorporates many advanced design and manufacturing refinements, resulting in superior ruggedness and accuracy.

Eliminate weak points

"Full-round" design does away with stress concentration points most frequently subject to failure . . . provides maximum live bearing area between pin, bushing and sidebars. As a result, stress is distributed evenly, increasing chain life.

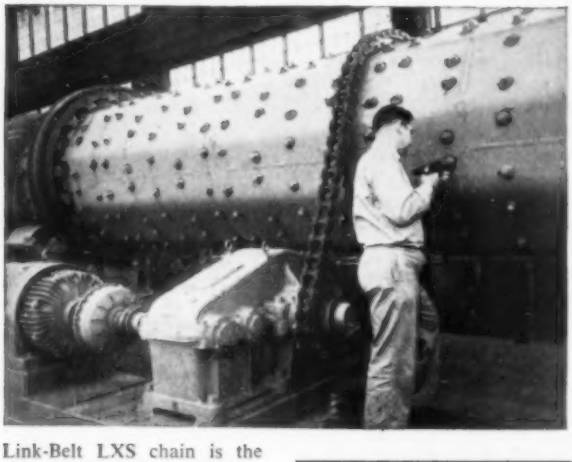
Pins and bushings are accurately sized for controlled press fit, preventing rotation in sidebars. Made from selected bar steel, sidebars are carefully machined for proper pitch hole size and for maintaining firm, tight press fit of pins and bushings. This assures close control of pitch and proper chain length after assembly.

Hardening extends life

Another Link-Belt long-life extra is the controlled hardening of selected steels used in the manufacture of LXS chain. Pins, for example, are made from a tough steel, specially treated for high strength in shear and for maximum wear value. Bushings are properly hardened to shrug off shock and resist wear.

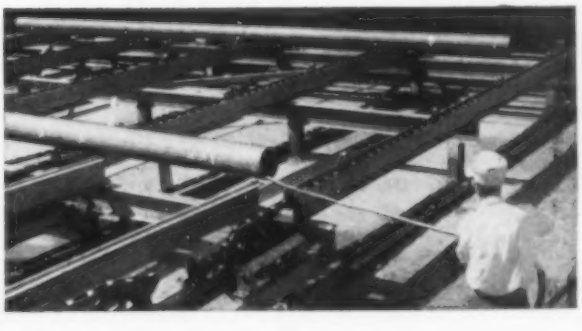
Rollers are accurately machined to assure proper operating clearances and free-rolling action. Controlled hardening gives them the necessary resiliency and durability.

LXS especially popular for exposed drives, high impacts



Link-Belt LXS chain is the long-life answer for exposed drives, abrasive and high-impact conditions. Its large, live bearing area reduces cutting action of abrasives because load is spread over a broad area.

Visit Our Exhibit, Space 31— Design Engineering Show, New York Coliseum, May 20-23



LXS chain provides extra strength, wear-life for heavy-duty conveying

Link-Belt LXS chain has real stamina—as shown in this conveyor application for handling 1000-pound, 40-foot lengths of steel pipe. Thanks to accuracy of pitch and attachment spacing, plus close matching of multiple strands, LXS has the added strength and wear life for the extra-long conveyors so popular in today's move to mechanization.

HEADQUARTERS for chains, sprockets and other Link-Belt conveying and mechanical power transmission products is your nearby Link-Belt factory branch store or authorized stock-carrying distributor.

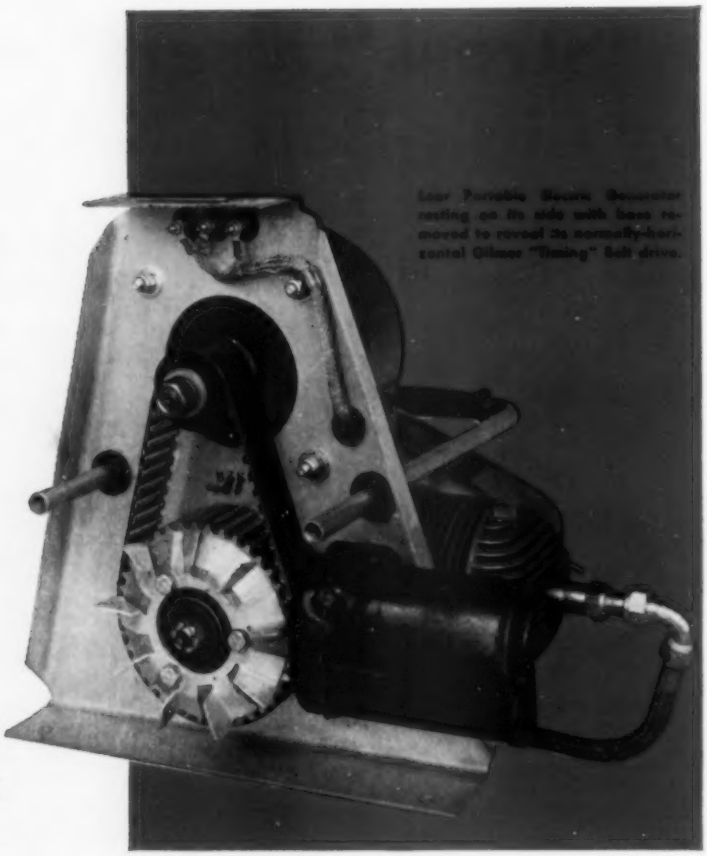
LINK-BELT

THE SYMBOL OF QUALITY LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,258

Required:
12,000 rpm...
and only a
Gilmer
"Timing" Belt drive
met the need...
with lightness and compactness



Lear Portable Electric Generator resting on its side with base removed to reveal its normally-horizontal Gilmer "Timing" Belt drive.

BUILT TO serve as a lightweight, foolproof source of emergency or auxiliary electric power, this new Lear Portable Electric Generator is a miracle of efficiency. Helping to make that miracle possible is the Gilmer "Timing®" Belt drive which Lear chose for the vital job of transmitting the power of the 3 hp. gasoline engine to the high-speed alternator.

This bantam power supply, occupying only 1½ cubic feet and weighing as little as 35 pounds, produces up to 1500 watts AC or 1350 watts DC. To achieve such efficiency the alternator is designed to operate at approximately *three times* the engine's 4000 rpm speed, or nearly 12,000 rpm! This means that the belt must travel at almost a mile a minute, even though very small-diameter pulleys are used.

For such an application no other type of drive of equal capacity can match the "Timing" Belt's lightness of weight, compactness, and ability to transmit full power at such high speed without slippage, without lubrication and without take-up or other maintenance! Lear's own literature points up these additional facts:

"Selected for its high efficiency, the flat tooth-belt drive assures a long, dependable operating life for both engine and alternator due to reduced radial bearing loads which this particular drive allows*. The belt is steel-cable-reinforced and will give long life and trouble-free service."

Your local NYB&P-Gilmer Distributor stocks standard "Timing" Belts and pulleys and will gladly help in obtaining special sizes you may require for original equipment. Consult your classified telephone directory for his name.

Larger 3500-watt Lear unit employs a compact 2"-wide Gilmer "Timing" Belt drive.

Positive tooth grip replaces friction grip, eliminates need for initial belt tension, lightens bearing loads.

Gilmer V-BELTS AND "TIMING®" BELTS

NYB&P INDUSTRIAL RUBBER PRODUCTS

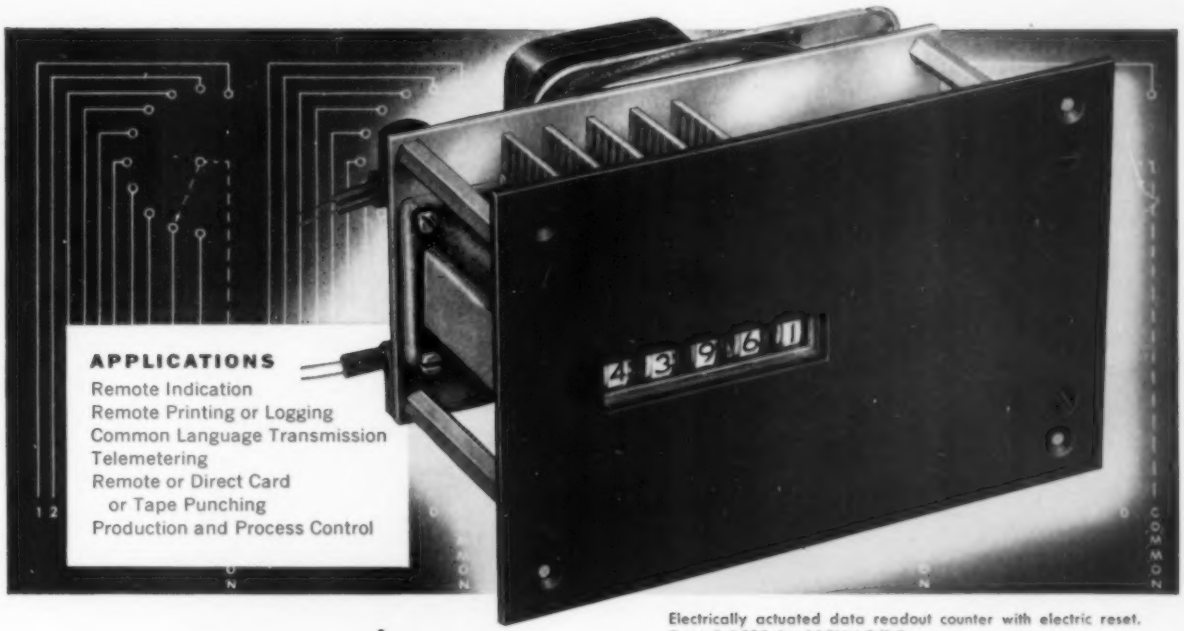
NYB&P — NEW YORK BELTING & PACKING CO. Founded 1846 — NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products

NEW

Data-Readout Counter

Provides 100,000 Distinct Circuit Arrangements



Electrically actuated data readout counter with electric reset. Form B-1538 for 110V AC/DC.

FUNCTIONS

Analog to Digital Conversion
Serial or Parallel Circuit Transmission
Continuous or On Demand Electrical Readout
Continuous Visual Readout
Visual and Electrical Data Storage
Predetermining
Repeat Predetermining
Sequential Programming

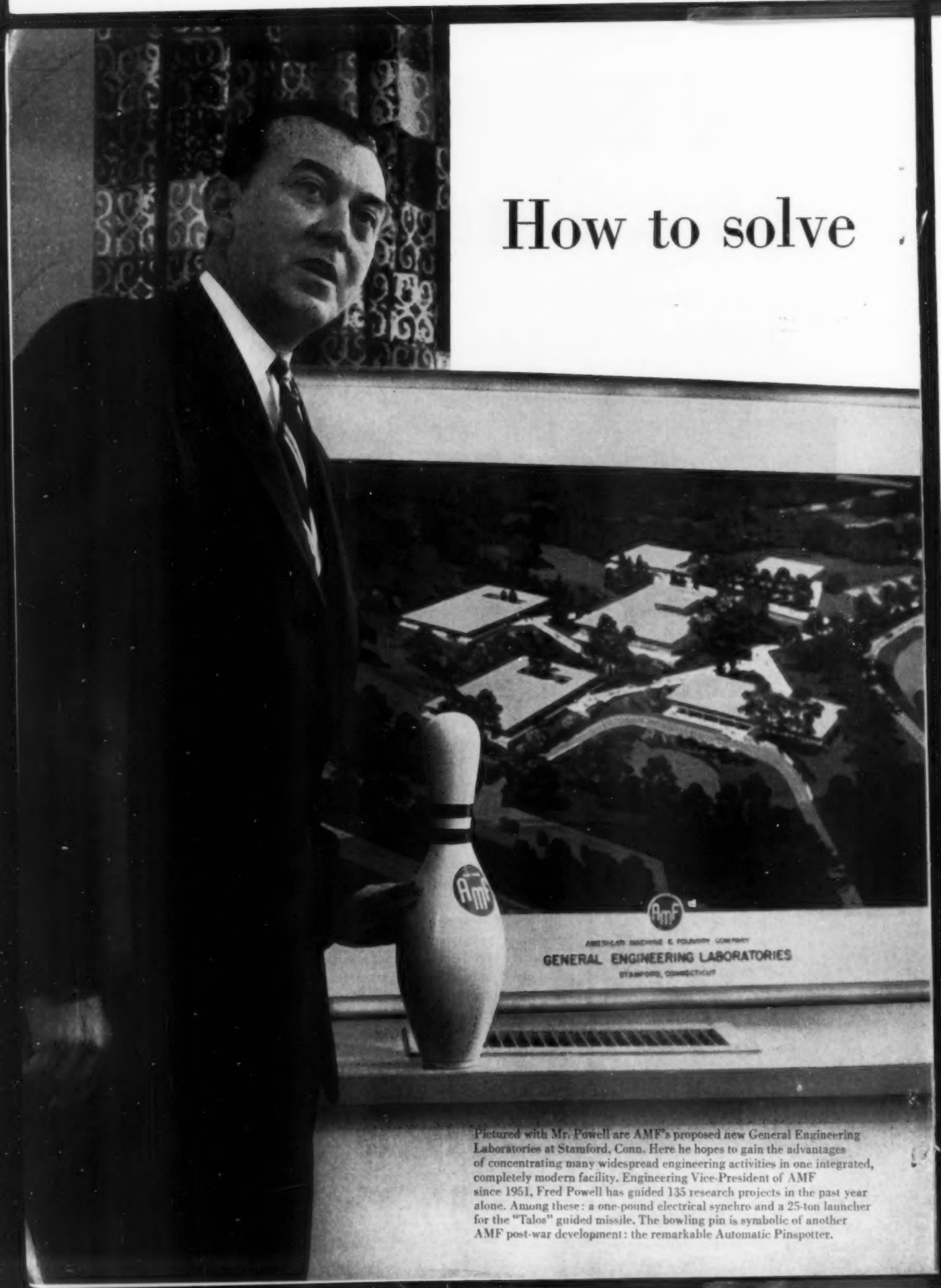
Veeder-Root's new series of Data Readout Counters combines visual indication with electrical readout for remote indication, recording, and controlling applications. *Electrically* or *mechanically* driven and provided with *manual* or *electric* reset, these counters present a positive display of accumulated totals and automatically create specific control circuit contact closures for each number visually displayed. Each instrument, with its five figure capacity, provides 100,000 distinct circuit arrangements which lend themselves to the most exacting control and transmission requirements. The counters are compatible with standard data processing equipment and offer a wide variety of applications in the industrial control and data processing fields.

Veeder-Root Inc.

"THE NAME THAT COUNTS"

Hartford, Conn. • Greenville, S. C. • Chicago • New York • Los Angeles
San Francisco • Montreal • *Offices and Agents in Principal Cities*

How to solve



Pictured with Mr. Powell are AMF's proposed new General Engineering Laboratories at Stamford, Conn. Here he hopes to gain the advantages of concentrating many widespread engineering activities in one integrated, completely modern facility. Engineering Vice-President of AMF since 1951, Fred Powell has guided 135 research projects in the past year alone. Among these: a one-pound electrical synchro and a 25-ton launcher for the "Talos" guided missile. The bowling pin is symbolic of another AMF post-war development: the remarkable Automatic Pinspotter.

a critical engineering need

"*AMF's post-war history has been one of expansion, great diversification, and intensified engineering research in many fields. Our Engineering Department of 1,600 people now works on design problems so complex and diverse that we are in constant need of the best information we can get on every useful development in materials, electric, electronic, and mechanical components. Without such information being readily available, the number of man-hours lost in seeking it adds up to a major engineering problem.*

"*It is obvious to us that currently maintained, constantly available, comprehensive, and accurately indexed files of manufacturers' catalogs are one of the most important assets our engineering offices can have. But to establish such files on an individual basis is a difficult, time-consuming job, and a costly one.*

"*Sweet's* PRODUCT DESIGN FILE *of manufacturers' catalogs is a far more efficient solution. We use it continually in our Engineering Departments. Its growth into a fully comprehensive service is important to all design engineers.*

"*To the extent that we can support and encourage the* PRODUCT DESIGN FILE*'s continued growth, everyone, it seems to me, will benefit: design engineers by having instant access, without lost time, to the product application and specifying information they need; manufacturers who supply us by making it possible for us to find out quickly the solutions to our problems they have to offer.*"

Fred K. Powell, Jr., *Vice-President, Engineering*
American Machine & Foundry Company
New York, N. Y.

What you want for your engineers, Mr. Powell, is what thousands of other engineers also want. Time and again they vote the PRODUCT DESIGN FILE their most valuable source of product comparison and specifying information...and tell us that its continued growth is the surest answer to their catalog problems.

Next year, more PRODUCT DESIGN FILES than ever before will be made available to industry's design engineers. In this 1958 File, hundreds of leading manufacturers will make selection and specifying information immediately and constantly available to you...all of it permanently bound, classified by product types for easy comparison, completely indexed for rapid use.

There is no better time-saving habit than to look first in your PRODUCT DESIGN FILE to find, compare and specify original equipment materials and components.

SWEET'S CATALOG SERVICE
Division—F. W. Dodge Corporation
119 West 40th Street, New York 18.

Designers, producers and distributors of manufacturers' market-specialized catalogs for the industrial and construction markets.
Over 53,000,000 catalog copies distributed for 1,740 companies in 1957.

Central Foundry Division's **atomic camera** speeds the development and production of railroad journal bearing frame adaptor

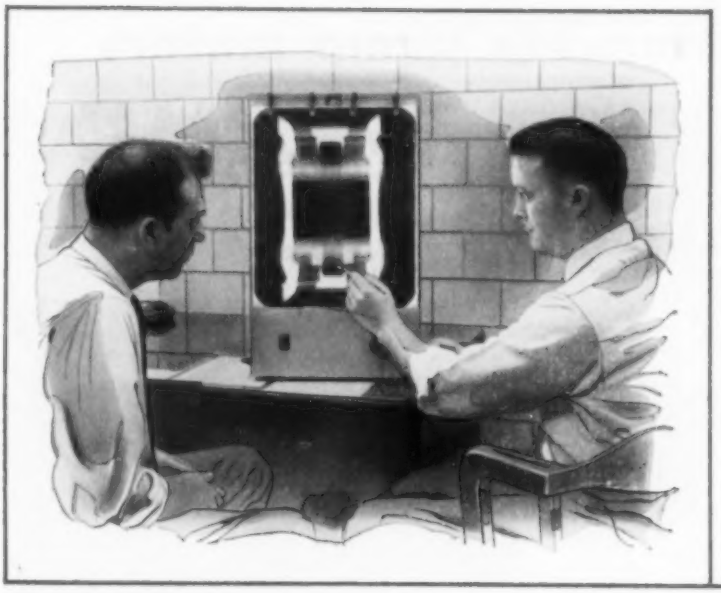
In experimental or new castings, time is an all-important factor. The problem is not only to get them as soon as possible but to get them *perfect*.

Central Foundry Division is now solving this by employing an Atomic Camera of the 30-Curie, Cobalt 60 type, which produces an "X-ray" picture of the casting's internal structure.

Analyzed by trained personnel, radiographs quickly and accurately reveal casting defects, and indicate where modifications must be made. They also point out where foundry gating technique can be improved to lower casting cost.

A typical instance in which Central Foundry's Cobalt 60 inspection process proved its value is on this 66-pound railroad bearing frame-adaptor casting (shown above).

In the same manner as in making medical X-rays, a film is secured behind the casting to be radiographed and the casting is then placed in front of the Cobalt 60 camera. As a safety measure, the radioactive pellet is positioned for the exposure by remote control from a radiation-proof room. The resulting radiographs show the entire internal structure of the casting.



Here trained specialists at Central Foundry Division analyze the radiograph. In the case of the railroad bearing frame-adaptor, radiography indicated that the number of gates could be reduced from 2 to 1 thus reducing costs. The resulting castings were sound (completely free from porosity). The fabricator will now be able to have quality castings, for experimental work as well as in production quantities.

The usual practice in checking for internal defects in a malleable or pearlitic malleable (ArmaSteel) casting consists of breaking up the casting in its white (unannealed) state, then double checking by later cutting an annealed casting . . . pieces of which are etched in acid. Besides the destruction of castings, this system is imperfect because there is no guarantee that the casting will be cut in an unsound area; should one exist. With Central Foundry's Cobalt 60 testing, there is NO PART OF THE INTERNAL STRUCTURE HIDDEN from careful scrutiny. In addition, the Atomic Camera can do a much better testing job in an hour than can be done in days by the usual methods.

The Atomic Camera at Central Foundry helps insure that new or experimental castings are sound. And it points the way to making alterations in gating and pouring methods, and can even show how to improve the design of the casting itself.

If you are interested in getting sound experimental as well as production castings —faster; eliminating the headaches of trial-and-error testing and disappointing results in the field, arrange for a consultation with our engineers . . . or write for the two new books, "Central Foundry Shell Castings", and "ArmaSteel".

77

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

In Leland submersible pump motors

GRAPHITAR® (CARBON-GRAPHITE) and GRAMIX® (PRODUCTS OF POWDER METALLURGY)

operate with gasoline

as the only

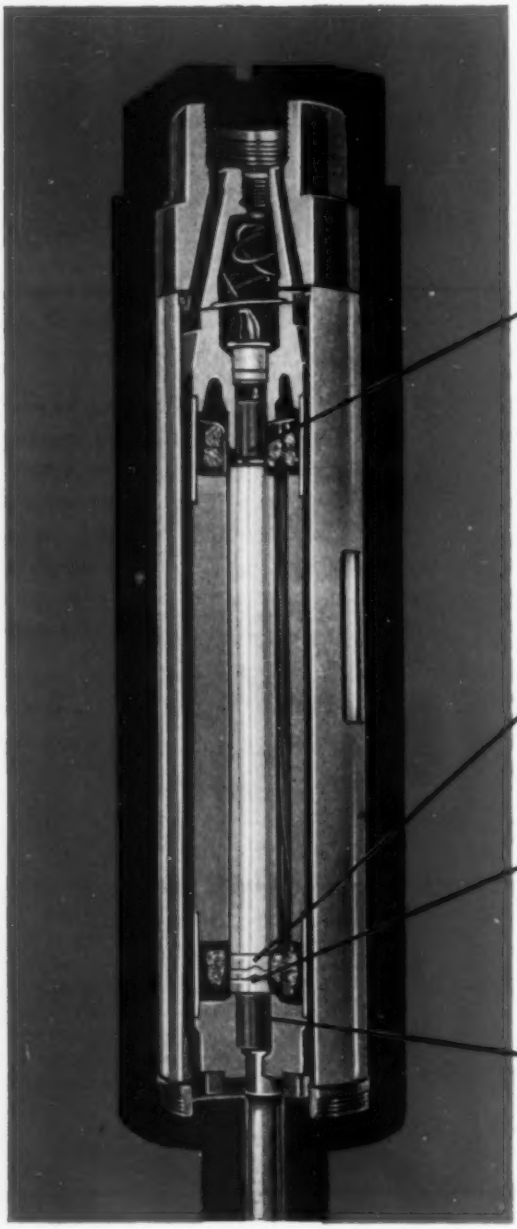
lubricant!

Running directly in gasoline, this superbly-designed Leland submersible motor embodies two GRAMIX thrust washers and two GRAPHITAR bearings to keep the operation of this amazing explosion-proof pump motor safe and smooth.

Thirty years ago the manufacturer of these pumps—the Leland Electric Co., Dayton, Ohio, a division of American Machine and Foundry Co., developed the first gasoline curb-pump motor to receive Underwriters' Laboratories' approval. Throughout their long experience, they have selected every component with great care. It is thus significant that for Leland's submersible motor they selected GRAPHITAR and GRAMIX bearings.

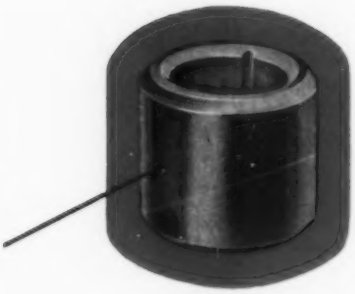
GRAPHITAR is a non-metallic, carbon-graphite material that will not weld or score even when in contact with a metal shaft. Any liquid will act as a lubricant, thereby reducing friction and increasing service life. With low-viscosity liquids such as gasoline, friction is at a minimum because of the low film strength.

GRAMIX, tough, long-wearing sintered-metal, has an extremely high particle hardness and excellent surface finish; can be precision die-pressed to tolerances within .0005". GRAMIX parts can withstand incredible amounts of pounding action. These factors, coupled with their extremely low cost, have helped add to the increasing use of GRAMIX parts in many industries.



THE UNITED STATES

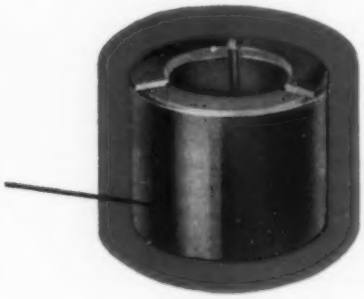
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



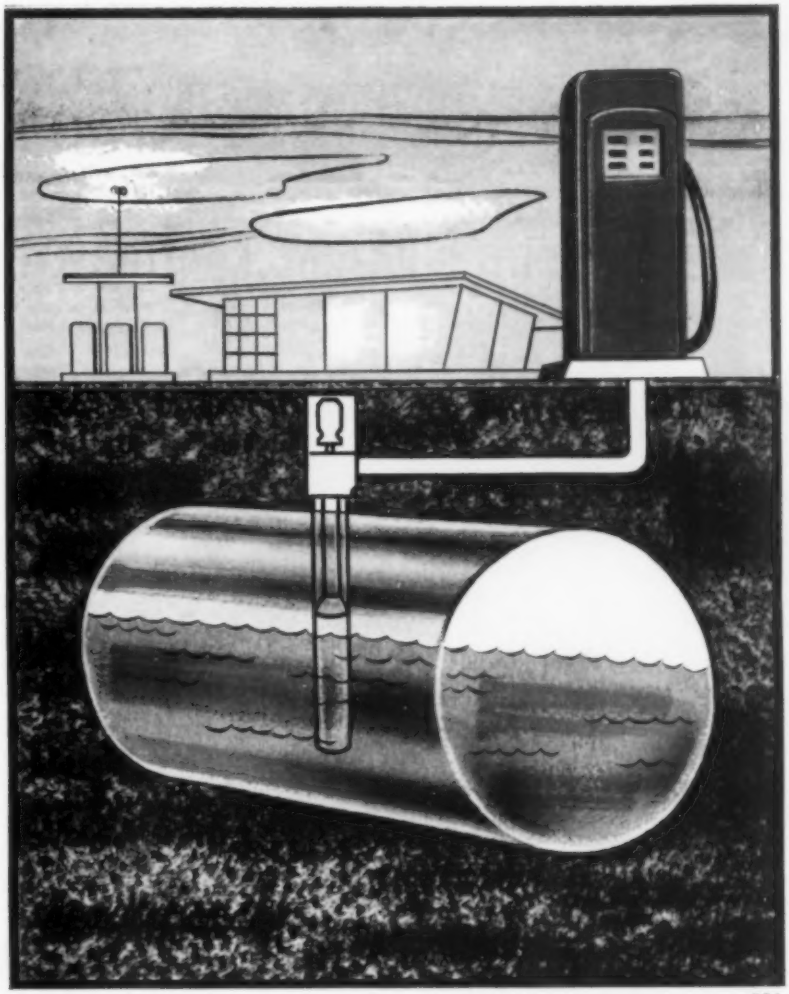
GRAPHITAR
GRADE 14
RADIAL BEARING

GRAMIX STEEL
THRUST BEARING
DRIVE

GRAMIX HARDENED
STEEL THRUST PLATE



GRAPHITAR RADIAL
AND THRUST BEARING



236

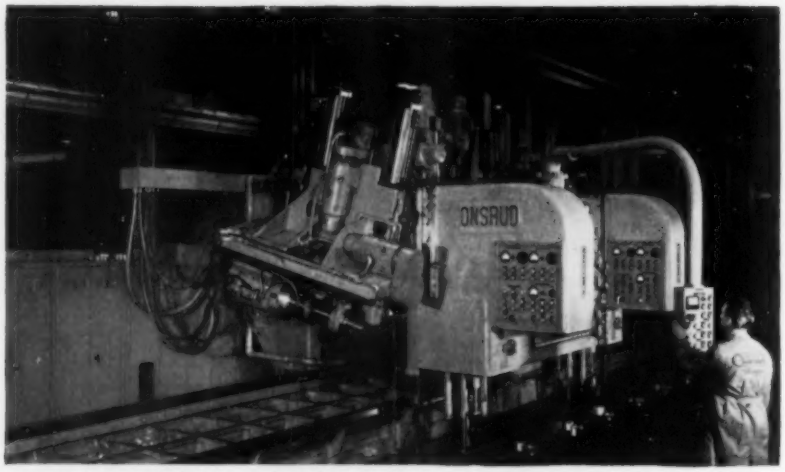
Write today for these two new engineering bulletins, GRAPHITAR Bulletin No. 20 and GRAMIX Bulletin No. 21.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

Designer's

General Electric tracer control systems meet every machine-tool need, speed production automatically



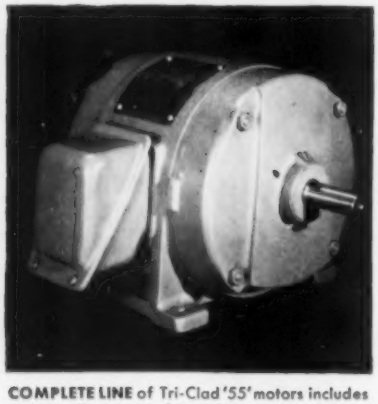
"A SYSTEM FOR EVERY MACHINE APPLICATION" includes a tracer control system for this 90-ton Onsrud contour milling machine. It directs twelve simultaneous cutter-feed motions, changes them at a rate much faster than possible by human hands, makes repeat cuts to accuracies of 0.002 inch.

To enable machinery designers to build fast, accurate, consistent production into lathes, milling machines, vertical boring mills and similar machines, General Electric offers a line of electric tracer control systems to operate machine tools. Five different systems can be applied singly or in combination to control any number of motions, in any machine application—automatically.

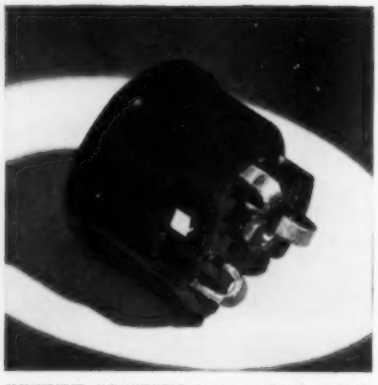
Basic function in all cases is the same—to direct motions of cutting tool or tools per directions stored in templates. In operation, cutting tool is guided over the work by a tracer head which automatically follows contours of template and controls speed of feed drives.

These completely engineered systems are applied to machines in close co-operation with machinery builders to provide integration of control and machine. For more data, see Bulletin GEA-6122.

Another motor "first"—inherent protection now available on TRI 55 CLAD polyphase motors (1-5 hp)



COMPLETE LINE of Tri-Clad '55' motors includes dripproof motors (shown), totally enclosed motors, and a full line of industry specified types. Many motors accessories are also available.



INHERENT PROTECTION—latest Tri-Clad '55' extra-value feature—responds to current and temperature, helps protect motor from overloads, stalls, and high ambient temperatures.

For the first time in the motor industry, built-in thermal protection is now available on General Electric's line of Tri-Clad* '55' foot-mounted, drip-proof 1800 rpm polyphase motors, as well as single-phase, ratings from 1- to 5-hp. This extra-value feature—now specified as optional equipment—responds to both current and temperature to help protect the motor from damage due to excessive overload currents, stalls or high ambient temperatures.

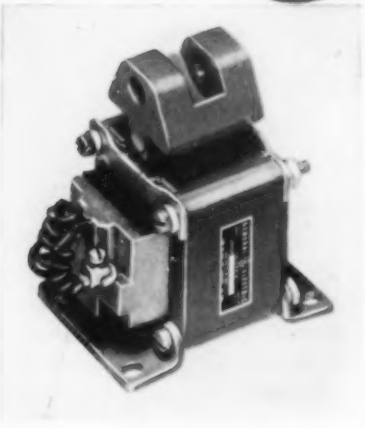
Add this to many other quality features built into the line, for example: improved operating characteristics, with full-load speed averaging 25 rpm higher than an old-design motor of same rating; better use of space for smaller, lighter design without sacrificing full-power performance; easy-access conduit box that rotates for connection from top, bottom or sides. See Bulletin GEA-5980.

*Registered trade-mark of General Electric Co.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS



Strongbox solenoids cover all ratings, mount 5 ways, require 22% less space

You can build straight-line mechanical force into your machine designs easier than ever with General Electric's line of industrial strongbox solenoids.

Complete rating coverage is supplied by nine basic frame sizes. These sizes provide more accurate selection in push or pull forms, 24 to 600 volts, 60 cycles, a-c and d-c. Nominal ratings at maximum stroke are: ½" pull—3.8 to 40 pounds; 1" pull—1.4 to 36 pounds; ½" push—2.5 to 33 pounds; 1" push—4.3 to 28 pounds.

Greater flexibility is provided because these versatile solenoids can be mounted in five different ways. Brackets can be moved to any of four sides, or thru-bolts can be used. Wiring is easier because both leads and built-in terminal boards (which may be connected if desired) are furnished on strong-box coils.

Longer life—proved by many customer applications—results from features such as laminated steel plunger and frame that are designed to distribute stress, glass fabric plunger guide that resists wear, and strongbox construction that resists entrance of oil, dust or moisture.

Smaller size—Up to 22% smaller for the same power ratings as previous models—permits a saving of space on your machines and smaller enclosure. This size reduction is made possible by more efficient utilization of steel, copper and insulation. For full details, see Bulletin GEA-6215.

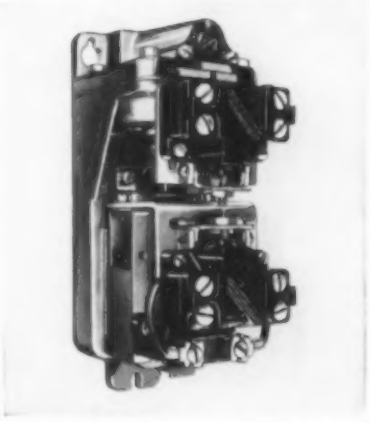
Pneumatic time-delay relays offer repetitive accuracy

Where high repetitive accuracy of a time-delay relay is needed—for example in machine-tool sequencing operations—make the General Electric pneumatic time-delay relay your choice. It provides repetitive accuracy of ±10 per cent of average time setting, including effects of variations in humidity and atmospheric pressure.

Relay affords stepless adjustment for a time delay ranging ⅕ to 180 seconds by turning a single screw, easily accessible from front of relay.

With snap-action silver contacts and strongbox coil, relay is designed to last for millions of operations, even on rapid-duty cycles. Greater dependability is provided by its rigid, die-cast aluminum construction, and a filtered air intake that keeps out dirt and dust.

Time delay can be arranged to time out after energizing or de-energizing.



Unit, rated at 25 amperes "make and carry", is available in open form or NEMA enclosures and with or without instantaneous closing contacts. See Bulletin GEC-1425 for details.

FHP machine-tool motor gets 10-year lubrication

Designed specifically for machine-tool use, these General Electric totally enclosed, fan-cooled fhp motors have ball-bearing construction with long-life grease to meet the heavy thrust conditions of many machine-tool applications.

Under normal operating conditions, factory lubrication with improved-type grease should last 10 years and reduce routine maintenance time and cost.

Welded-on steel base gives strong, solid mounting that withstands shock and vibration, maintains accurate motor alignment. Compact, yet sturdy construction can simplify your design and assembly problems.

Years-ahead motor design enables these motors to meet the tough requirements of frequent start-stop service and plugging. Ratings are ¼, ⅓, ½, ¾ hp in 60/50 cycles, at voltages of 208–220/440, 220/380, 500. For additional details, send for Bulletin GEC-1306.

General Electric Co., Apparatus Sales Division, Section C668-134, Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference purposes

- ☐ GEA-5980 Tri-Clad '55' motors (1-5 hp)
- ☐ GEA-6122 Tracer Control systems
- ☐ GEA-6215 Strongbox solenoids

× for immediate project

- ☐ GEC-1306 Fhp machine-tool motors
- ☐ GEC-1425 Pneumatic time-delay relay

Name ..... **Company** .....

City ..... **State** .....

Designing with BAKELITE BRAND Plastics

- ***Durability plus quality appearance***
- ***Precise small parts that resist chemicals***
- ***New trick with a coating***

Here are three materials whose properties can help you solve design problems. One is a general-purpose phenolic plastic notable for its strength and appearance. Another is C-11, a tough plastic that resists staining. The third is an abrasion-resistant vinyl organosol, a coating with eye-appeal to match its proven durability. These are just a sample. The hundreds of BAKELITE Brand Plastics provide a tremendous range of properties to improve design, effect production economies. Remember: Bakelite Company offers larger resources, longer experience, and a greater variety and number of plastics—vinyls, epoxies, polyesters, phenolics, polyethylenes, styrenes, silicones and impact styrenes.

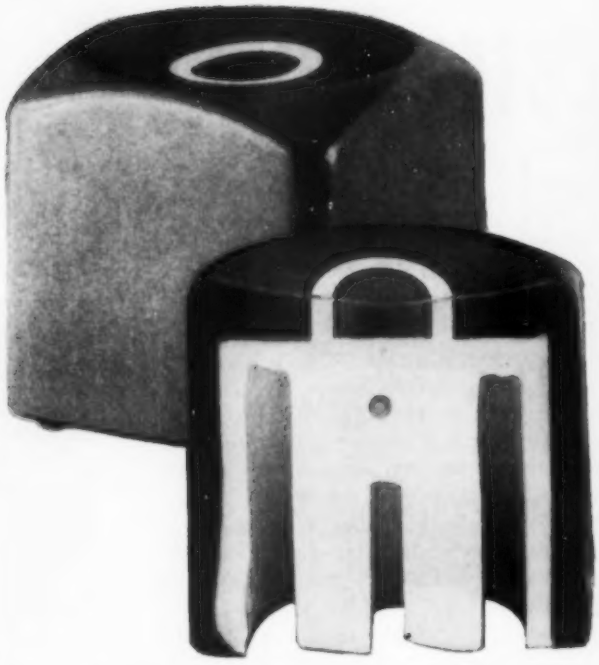
1 Designed for strength and beauty— with phenolic plastic above and below

Where the treatment is roughest—on the cover and base—the manufacturer of this electric hassock fan uses parts molded of BAKELITE Brand Phenolic Plastic BMG-5000. This material keeps its fine surface finish and rich color. It provides cleanly-molded details that point up the fan's quality construction, and aid in fast, faultless assembly. And, as a sales point, the manufacturer emphasizes that the cover and base of the fan will resist food acids, beverages, soaps, and detergents. BMG-5000 offers your plastics molder the best combination of molding and end-use properties. It requires a minimum molding cycle, so pieces with high gloss and superior strength properties can be produced fast. As for its performance properties, see the table at right. They are taken from the BAKELITE Molding News "Field Report," Vol. 1, No. 10, which also describes several typical products. Write Dept. XG-145.

BMG-5000
Typical Test Values

Values from Electrical Tests			
Dielectric Strength (D149-44) Short time, volts/mil	370		
Volume Resistivity (D257-54T) megohm-cm.	10^6		
	60 c.	1 kc.	1 mc.
Dielectric Constant (D150-54)	5.7	5.3	4.6
Dissipation Factor (D150-54)	0.07	0.04	0.03
Values from Miscellaneous Tests			
Molded Specific Gravity (D392-38) Black 25			1.34
Brown 15			1.36
Heat Distortion Temp. (648-45T), deg. F. (½ in.-264 psi)			330
Thermal Conductivity cal./cm.²/sec./deg.C/cm.			5×10^{-4}
Moisture Sensitivity: Water Absorption (D570-54T) per cent wt. gain			.45
Saturation Constant (WC-78-B-2), per cent			8.0
Diffusion Constant (WC-78-E), cm²/hr.			1.3×10^{-5}
Values from Mechanical Tests			
Izod Impact Strength (D256-54T) Ft.-lb./in. of notch			0.30
Compressive Strength (D695-54T), psi			34,000
Tensile Strength (D651-48) (⅛"), psi			8,400
Shear Strength (D732-46) (⅛"), psi			13,000
Flexural Properties (D790-49T): Flexural Strength, psi			10,000
Modulus of Elasticity in Flexure, psi			1×10^6

This "Air Flight" circulator has both cover and base molded of BAKELITE Phenolic Plastic BMG-5000. Note particularly the elaborate one-piece molded construction of the base.



"Two-shot" molded typewriter key—the outer shell is molded first, while the letter and the key lever slot are molded in the second shot to complete the button.

The leather-like textured finish gives the "Soundscriber 200" a high-quality look. And since the machine is portable, it is imperative that the finish be tough and abrasion-resistant—as soundly engineered as the machine itself.

2 "Two-shot" molded parts of C-11 Plastic—Highly Accurate, Tough, Chemical-Resistant

The key buttons above are typical of the small parts molded of BAKELITE Brand C-11 Plastics for IBM electric typewriters and accounting machines. The choice of C-11 was based on its resistance to staining by inks, carbon paper, oil, and cleaning fluid, together with toughness, accuracy in molding, and smooth, comfortable finish. It can be made clear or colored . . . and is a plastic that can be used in many home products, packaging, and mechanical parts. Several other applications and properties of C-11 are discussed in BAKELITE Molding News Vol. 1, No. 4. Write Dept. XH-145.

3 "Leather-textured" Vinyl Finish Designed to take hard knocks

The exterior finish of the "Soundscriber 200" portable dictating machine is a specially formulated organosol coating based on BAKELITE Brand Vinyl Resins—able to take the knocks of travel and still look attractive. The leather-like textured finish gives the "200" a high-quality look. And since the machine is portable, it is imperative that the finish be tough and abrasion-resistant—as soundly engineered as the machine itself. Colors are virtually unlimited with organosols based on BAKELITE Vinyl Resins. Write Dept. XK-145 for "Industrial Applications for Vinyl Resin Finishes."

See Bakelite Company exhibit
2nd Design Engineering Show
May 20-23, N. Y. Coliseum,
Booths #1005, 1009, 1013, 1019, 1023

There's more to design with in

BAKELITE BRAND PLASTICS

POLYETHYLENES • SILICONES • POLYESTERS • EPOXIES
PHENOLICS • IMPACT STYRENES • STYRENES • VINYLS

BAKELITE COMPANY, *Division of Union Carbide Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC.

Mr. John S. Lea, Vice President, Kelley Manufacturing Company, Houston, Texas, reports:

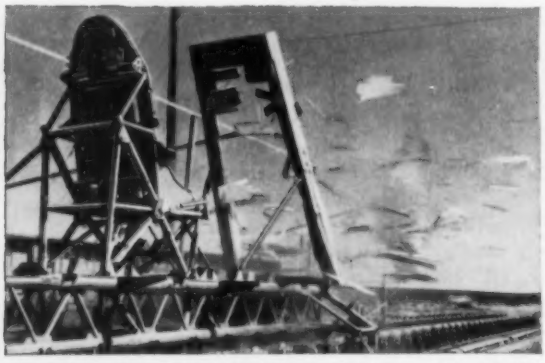
"Republic Electro Paintlok® forming and application

"Republic Electro Paintlok is the ideal material for one of our major product lines, acoustical fastening members," continues Mr. Lea. "Fabricating the sheet into H and Z members, splines, angles and couplers requires extreme forming and bending. We know from past experience that the special coating on Republic Electro Paintlok won't crack, flake or peel off no matter what we do. This means that after painting and installation, Kelley Acoustical Fastening Members provide our customers maximum satisfaction almost indefinitely, with little or no maintenance at all."

This example is typical of the improvement made possible in an endless variety of products through the use of Republic Electro Paintlok. In addition, this versatile sheet often allows substantial savings in production time and money because it is shipped from the mill in prime condition for painting. In many cases only the final finish need be applied to provide full protection and attractive appearance. Cleaning and priming may be eliminated.

Finally, the chemically treated zinc surface of Electro Paintlok retards corrosion even when scratched through, and effectively limits it to the point of damage.

Get all the facts on this versatile sheet steel product and how it can help solve your forming and application problems. Simply contact your Republic representative or mail coupon.



STRUCTURAL APPLICATION PROBLEMS requiring low weight plus high strength are best solved using tubular construction. A good example is this rocket sled designed to withstand extreme forces of abrupt deceleration. Republic ELECTRUNITE® Steel Mechanical Tubing is ideal for such an application. Uniform in wall thickness, concentricity, strength and ductility, it permits reduction in bulk without sacrifice of safety. Send coupon for data.

CORROSIVE APPLICATION PROBLEMS, like this coal-cleaning plant disc-type filter unit, demand the strength and corrosion resistance of Republic ENDURO® Stainless Steel. Here the stainless steel cloth used to cover disc segments is not only much more durable, but more than twice as efficient in recovering coal "fines" as the cotton cloth formerly used. To be sure of the best, specify ENDURO.

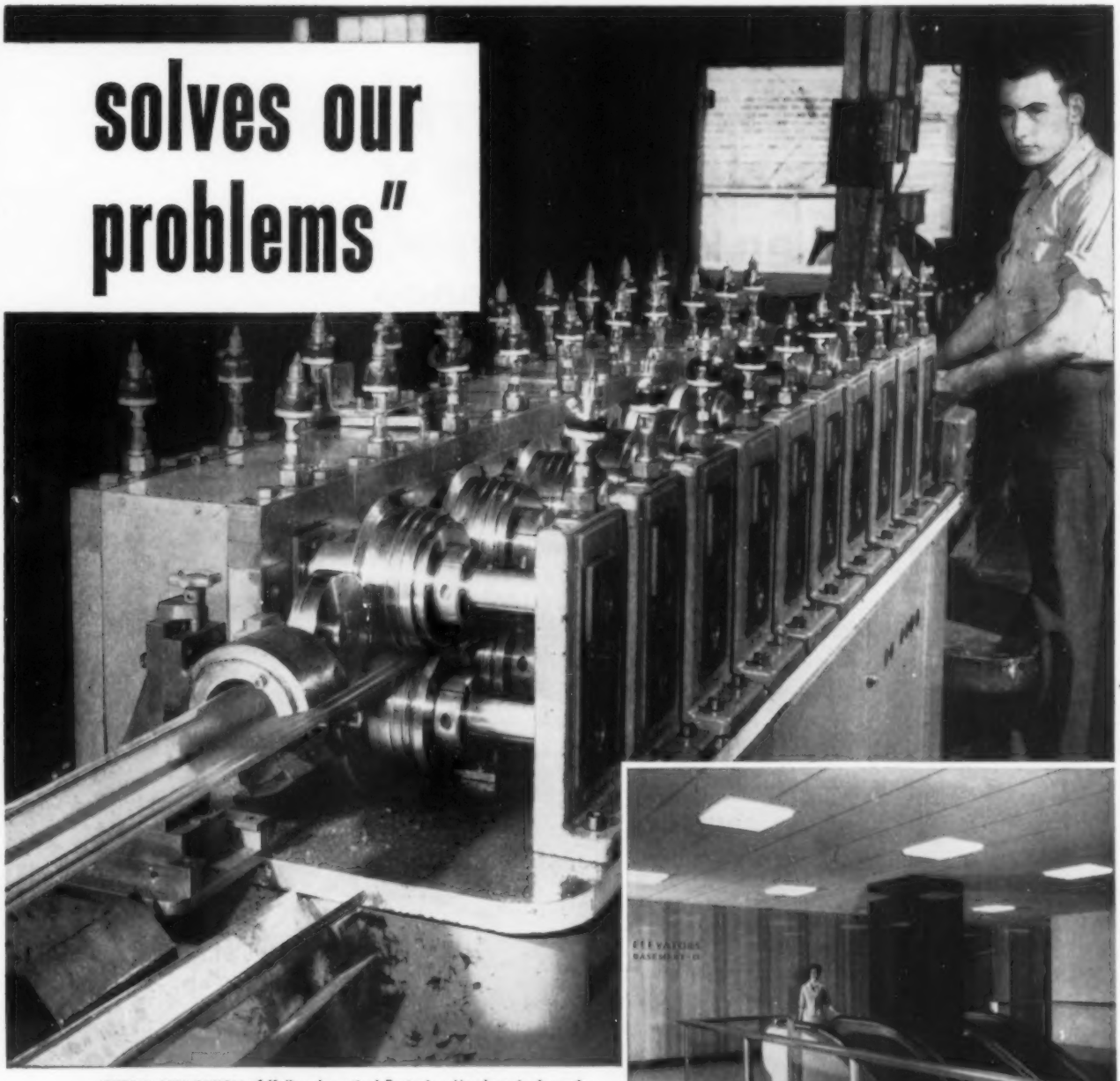
REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

Visit Republic at the Design Engineering Show, BOOTH 1726. Discuss your design and material problems on Stainless Steel, Tubing.

solves our problems"



TYPICAL APPLICATION of Kelley Acoustical Fastening Members is shown in the ceiling at right. Base metal is Republic Electro Paintlok. Its special coated surface grips paint tightly, assuring years of maintenance-free good looks. Even severe forming, like the operation shown above, has no effect on its outstanding paint-holding characteristics. Coating will not crack, flake or peel off.

STEEL

and Steel Products

Iron Powder, Titanium, Nylok Bolts, Plastic Pipe, with our engineers.

REPUBLIC STEEL CORPORATION
Dept. C-3071
3150 East 45th Street
Cleveland 27, Ohio

Please send me more information on:
☐ Electro Paintlok ☐ ENDURO Stainless Steel
☐ ELECTRUNITE Mechanical Tubing

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

KLIXON THERMOSTAT HELPS NEW EASY

Combination Washer-Dryer win dealer, public acceptance

With the new Easy combination washer-dryer a housewife just pushes a button and her clothes are "delivered" just the way she orders . . . washed, rinsed, dried . . . ready to iron or put away.

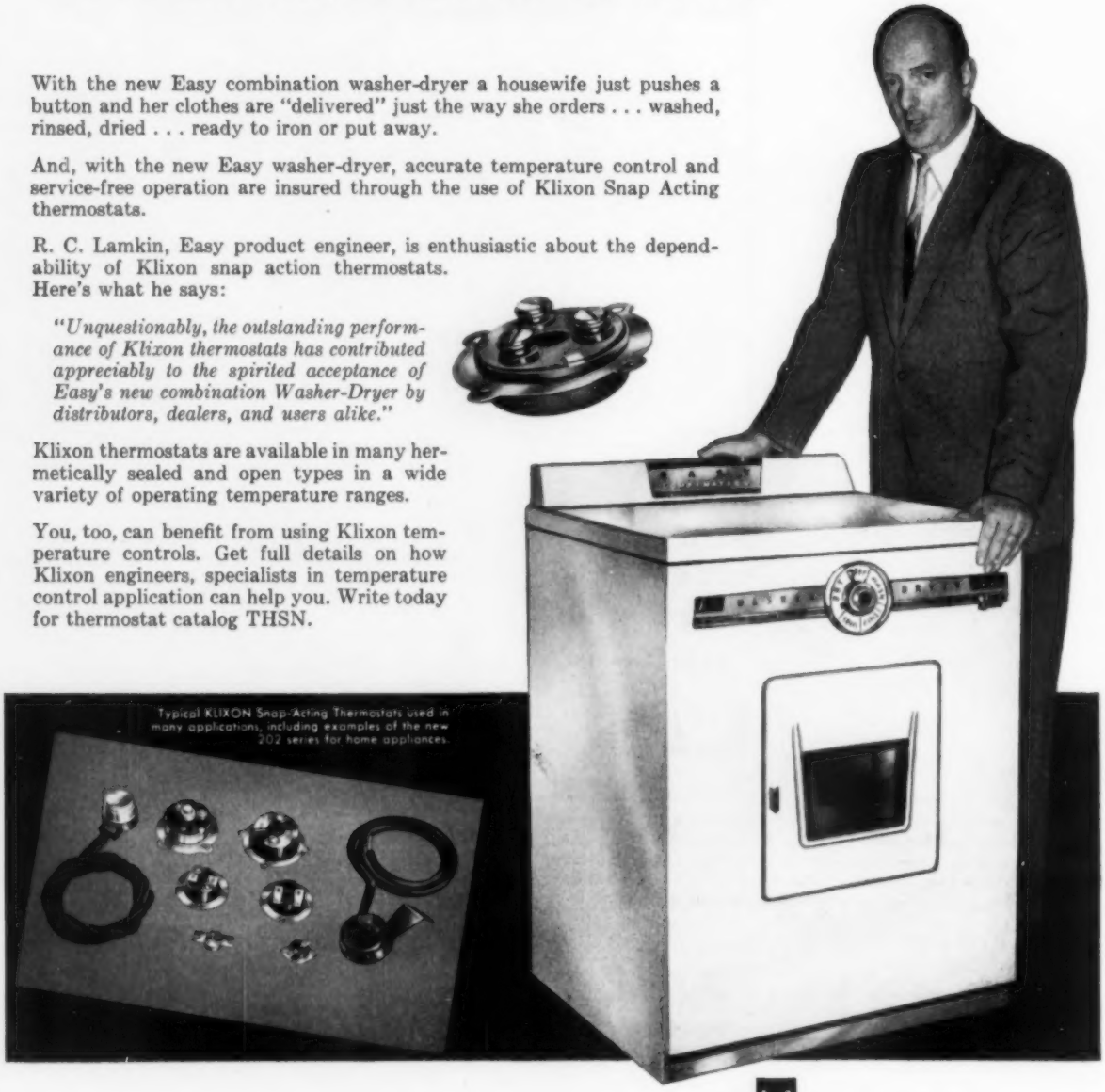
And, with the new Easy washer-dryer, accurate temperature control and service-free operation are insured through the use of Klixon Snap Acting thermostats.

R. C. Lamkin, Easy product engineer, is enthusiastic about the dependability of Klixon snap action thermostats. Here's what he says:

"Unquestionably, the outstanding performance of Klixon thermostats has contributed appreciably to the spirited acceptance of Easy's new combination Washer-Dryer by distributors, dealers, and users alike."

Klixon thermostats are available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

You, too, can benefit from using Klixon temperature controls. Get full details on how Klixon engineers, specialists in temperature control application can help you. Write today for thermostat catalog THSN.

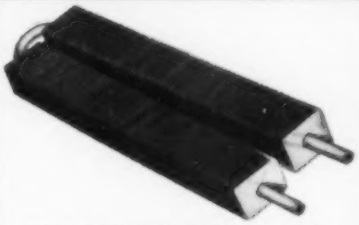


Typical KLIXON Snap-Acting Thermostats used in many applications, including examples of the new 202 series for home appliances.

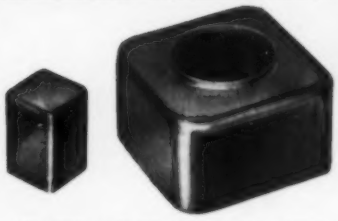
METALS & CONTROLS CORPORATION

Spencer Thermostat Division 3805 Forest Street, Attleboro, Mass.

KLIXON®

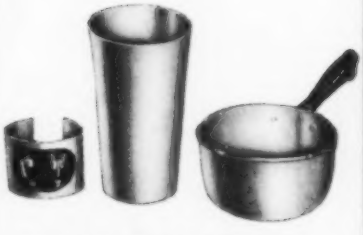


HEAT TRANSFER UNITS — ALCUPLATE provides ideal fin sections at reduced cost over solid copper fins. The copper surface permits soft soldering of the fins to the tubes.



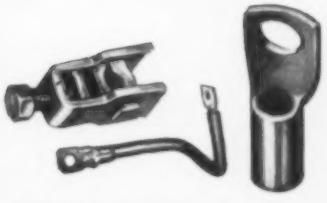
COMPONENT CASES — ALCUPLATE is successfully drawn and formed into lightweight cases or cans and intricate parts . . . ideal for hermetic sealing.

BUS BARS — ALCUPLATE provides high conductivity, light weight, solderability . . . is lower in cost than solid copper bus bars.

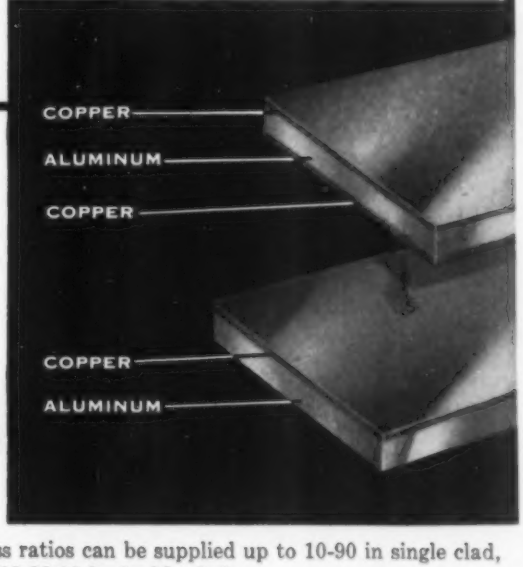


DRAWN AND FORMED PRODUCTS — ALCUPLATE, with its pleasing appearance, is an ideal metal for giftware and gourmetware.

ELECTRONIC CHASSIS — ALCUPLATE offers the advantages of minimum weight plus the copper surface needed for soft soldering, electro-plating and low-resistance shield connections.



ELECTRICAL TERMINALS — ALCUPLATE eliminates galvanic corrosion which otherwise results from aluminum and copper junctions.



These products have something in common — They're all made of versatile, low cost General Plate

ALCUPLATE®

General Plate ALCUPLATE is a clad metal made by bonding solid copper on one or both sides of aluminum.

The copper surfaces of G. P. ALCUPLATE have all of the properties of solid wrought copper, but when bonded to the aluminum, there is a substantial reduction in overall weight, with cost savings of up to 30%.

G. P. ALCUPLATE is available in coils or cut lengths, in thicknesses up to 1/16" and widths up to 14". Thickness ratios can be supplied up to 10-90 in single clad, or 10-80-10 in double clad.

G. P. ALCUPLATE is an excellent thermal and electrical conductor. It is easily formed, deep drawn, or spun, and it offers ideal surfaces for fine finishing.

Write today for complete details on versatile G. P. ALCUPLATE — ask for Bulletin 702E.

You Can Profit By Using General Plate Clad Metals

METALS & CONTROLS CORPORATION

General Plate Division

1005 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK, CHICAGO, DETROIT, MILWAUKEE, LOS ANGELES

LONGER SOLENOID LIFE...

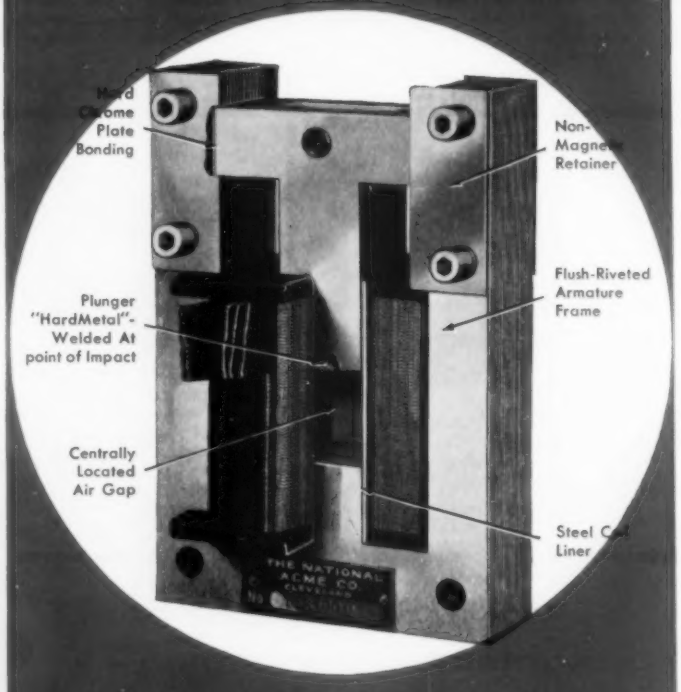
with NAMCO'S exclusive "HARDMETAL"-welded plunger bonding

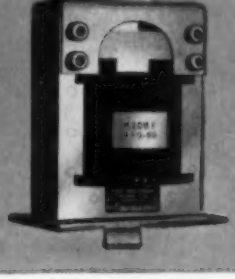
Standard or Custom Models To Fit Your Design

"HardMetal"-welded plunger bonding prevents mushrooming at the vital point of impact—withstands incessant pounding of the plunger on the frame. Long plunger life, and thus long solenoid life, is further insured by hard chrome plating upper guide edges of plunger laminations to reduce friction and wear.

Namco standard solenoids are available in six series of pull and push types; custom-engineered solenoids in every size and type can be made to meet your specifications.

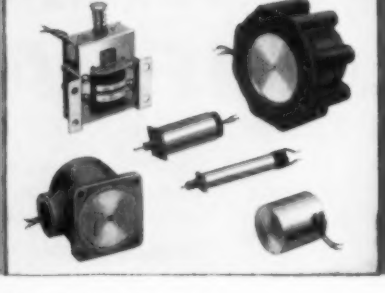
Standard "HardMetal"-Welded Solenoids are furnished push or pull type in sizes with ratings from 2-1/2 to 21 pounds at 1/2" stroke and from 2 to 25 pounds at 1" stroke.





← Saddle stop applied to Series K200 standard Namco push type solenoid.

To meet specific job requirements, solenoids of special shapes and sizes are designed and built through cooperation of our engineers with yours. →



Ask us to send a National Acme Representative to discuss your problems, or if you want more information first — send for BULLETIN EM-52.

ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL ACME COMPANY • 170 EAST 131ST STREET • CLEVELAND 8, OHIO

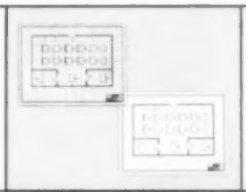
FROM BRUNING—YOUR ONE CONVENIENT SOURCE FOR ALL DRAFTING NEEDS...

7 WONDERFUL TIME-AND WORK SAVERS!

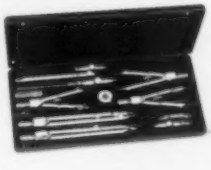
Bruning Electric Erasing Machine, shown at left, saves hours of finger-cramping manual erasing, lets you do a neater, safer erasing job. Extra-long, 7-inch eraser.

The *right* tool or material for the job, whether it's a large or small item, means a lot in drafting! That's why the outstanding drafting aids featured here are important to you. That's why they are important members of Bruning's complete quality line. Try them; you will be mighty pleased at how fast the savings of time and labor mount up.

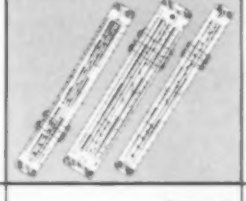
"Visi-Vel" Tracing Paper
This wonderful new resin-transparentized tracing paper offers up to 25% faster reproduction speed, unsurpassed toughness, durability, and permanence. Accepts pencils as hard as 9H, and areas can be erased repeatedly without damage to drawing qualities. Rolls or sheets. Thin, medium, heavy weights.



"Grid-X" Tracing Paper
The cross section lines eliminate time-consuming measurements, speed and improve lettering. They do not reproduce, so prints show only lines you draw. "Grid-X" saves time and work on scale drawings of irregular shapes, sketches, plant layouts . . . in fact, on almost any drawing. Pads, sheets, and rolls.



Wild Stainless Steel Instruments
Now, get the higher precision, lifetime durability and beauty offered only by the instruments made entirely of stainless steel. They will not oxidize, cannot be damaged by perspiration. Specially hardened swivel-type pen nibs are easy to clean, will remain sharp. Swiss precision-made. Moderately priced.



"Eye-Saver" Slide Rule
The green-yellow color of this all-metal rule provides easier, more accurate reading. It prevents reflected glare, brings scales into sharp, true focus, provides optimum contrast with scale graduations. Rule can not be damaged by moisture and severe wear and tear, is unaffected by temperature changes.

"Mobile" Parallel Straightedge
It rolls freely and smoothly over your drawing on retractile rollers located on the underside of the blade—lets you make neater drawings, faster and easier! Rollers retract under slight pressure, won't damage or mark your drawing. Easy rolling action permits fingertip positioning of the edge.

Wrico "Zephyr" Lettering Set
Now, get the work-saving advantages of a modern scriber-type lettering set . . . for less than ten dollars! Unique skid-proof runners keep the guide holder securely in position for perfect lettering. Three popular sizes of letters and numbers provide a versatile lettering combination.

America's Leading Supplier of Engineering and Drafting Equipment

BRUNING

Offices in 37 Cities of the U.S. and Canada

CHARLES BRUNING COMPANY, INC., CHICAGO

In Canada: Charles Bruning Company (Canada) Ltd., 105 Church St., Toronto 1, Canada

Charles Bruning Company, Inc., Dept. 54-0
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on ☐ Electric Eraser
☐ "Visi-Vel" Tracing Paper ☐ "Grid-X" Tracing Paper
☐ Wild Instruments ☐ "Eye-Saver" Slide Rule
☐ Parallel Straightedge ☐ Wrico Lettering Set

Name_____ **Title**_____

Company_____

Address_____

City_____ **County**_____ **State**_____

New Westinghouse *Life-Line H* with silicone insulation

10 TIMES LONGER INSULATION THAN ANY OTHER STANDARD

Production Increases with Life-Line® "H" because you get top performance – reduced maintenance and down time. Here's how:

High-Temperature Silicone Insulation combined with the full complement of iron and copper for low-temperature standards – 60°C rise. Life-Line "H" insulation will last 10 times longer than ordinary Class B under all temperature conditions.

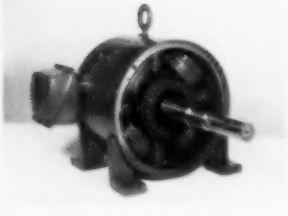
Controlled Ventilation – a new concept in motor cooling and cleaning – gives more capacity, longer life, and protection against damaging brush dust.

Fastest Response of any industrial d-c motor on the market – armature inertia reduced up to 55% – commutating ability increased 35%. You get closer regulation, faster accelerations, quicker reversals.

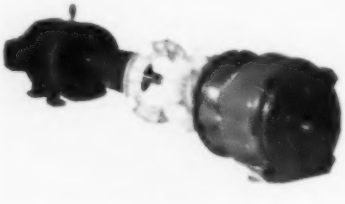
Greatest Protection of any industrial d-c motor through new housing design. In most cases, eliminates need for a splash-proof motor.

It's All New – with longer life, greater dependability, top performance. For all the facts about the Life-Line "H" call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

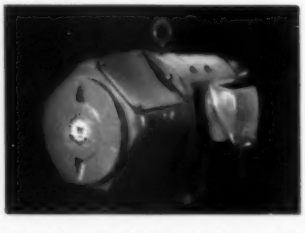
J-21990



New Silicone-Insulated Life-Line "H" is built and rated to meet low-temperature Class B standards. Insulation is eliminated as a limiting factor on motor life under normal conditions. Even with emergency overloads, Life-Line "H" will go right on working in many cases when ordinary Class B would fail.



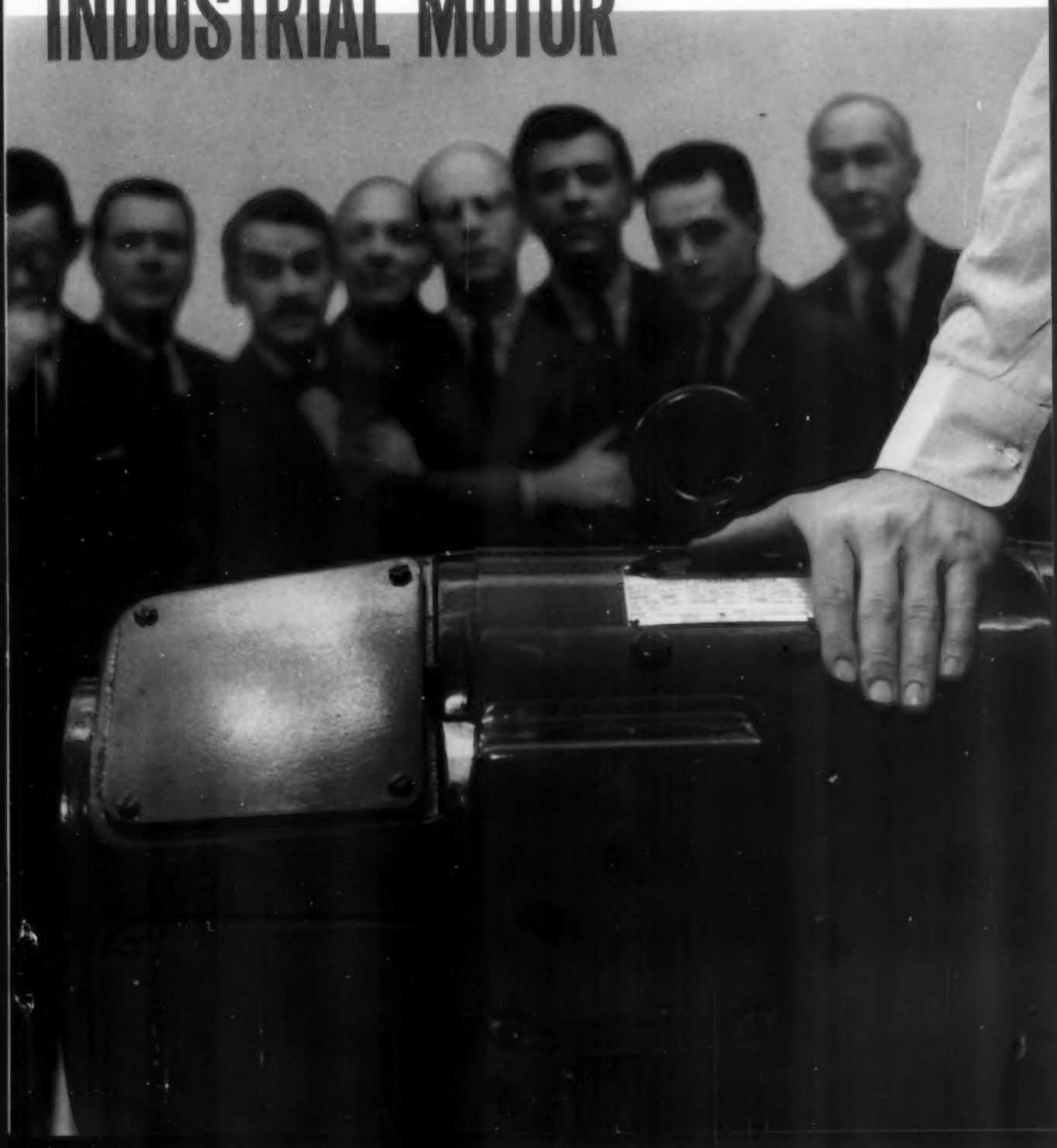
New Controlled Ventilation moves more air, positively distributes it to best advantage, cleans machine parts instead of contaminating them. Result – armature inertia can be reduced for faster response. Life-Line "H" lasts longer, increases production because maintenance and down time are reduced.



New Standard of Protection – All commutator access openings have sealing covers – ventilation openings face down. Dripping or running liquids are excluded. Maintenance and down time are reduced. Need for splash-proof machines eliminated in most cases.

YOU CAN BE SURE...IF IT'S Westinghouse

LIFE...MORE EXTRA-CAPACITY INDUSTRIAL MOTOR



Available in
Stainless Steel
Plated Steel
Monel

Spherical
Elliptical
Cylindrical

From 2″ to 14″ diameter.

For pressures from vacuum to 4800 lbs.

Here's Why

Nicholson precision welded floats are better, last longer

No mere thin-walled copper floats, these—but high tensile strength precision welded steel floats with extraordinary resistance to pressure and corrosion! Nicholson Floats give you such outstanding advantages as—

Die-formed float halves with inward rolled edges—not spun, laminated or electrodeposited;

Uniform wall thickness—float halves annealed after draws to prevent cracking;

Butt-welded seams—forming a reinforcement ring, to give floats greater resistance to external pressure.

Steel floats can be supplied—in quantity—with chromium, cadmium, or copper plating . . . or with sand-blast or pickled finish. Stainless steel and Monel floats can be furnished—in quantity—rough-buffed, polished, or with welds ground smooth and highly finished for easy sterilization and cleaning.

Nicholson can deliver precision welded floats to fit your production schedule. Today, thousands of Nicholson Floats are in service—most as buoyancy mediums . . . many as fluid chambers and pressure vessels, as well. Write for details about the complete Nicholson line.

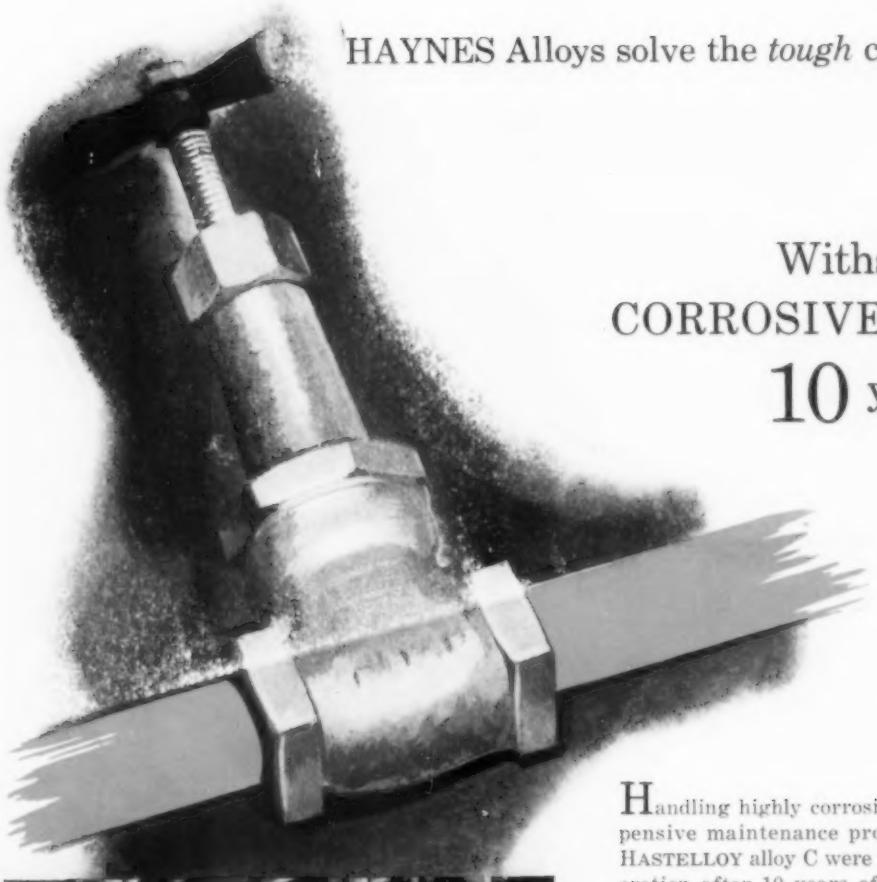
NICHOLSON

W. H. NICHOLSON and Company

FLOATS • TRAPS • VALVES • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES

HAYNES Alloys solve the *tough* corrosion problems

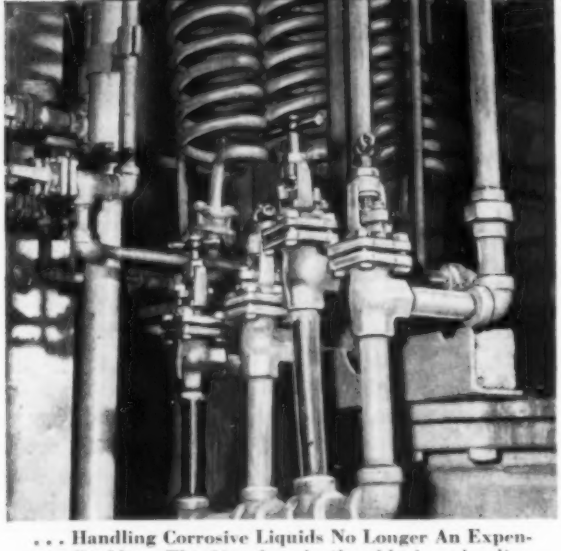


Withstands CORROSIVE CHLORINE 10 years!

Handling highly corrosive liquid chlorine was an expensive maintenance problem—until valves made of HASTELLOY alloy C were installed. They are still in operation after 10 years of service and are expected to last indefinitely.

This is just one of the many corrosion difficulties met by HAYNES Alloys. They also have excellent resistance to hot mineral acids, strongly oxidizing salts, powerful gaseous oxidants, and combinations of these media over a wide range of temperatures and concentrations.

The booklet "HASTELLOY Corrosion-Resistant Alloys" describes these alloys that are solving corrosion problems in many industries—write for your copy.



. . . Handling Corrosive Liquids No Longer An Expensive Problem. The 30 valves in the chlorine pipe line required constant maintenance. Before valves made of HASTELLOY alloy C were installed, 3 to 4 of the thirty valves had to be replaced each week. Now . . . maintenance is simply periodic inspection and repacking.

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles
New York • San Francisco

HAYNES TRADE-MARK ALLOYS

"Haynes" and "Hastelloy" are registered trade-marks of Union Carbide and Carbon Corporation

THIS RESIN COMES FIRST...

FOR TOOL HANDLES THAT LAST

EXON 654...specifically for protective dip-coating

Typical of the Pin-Pointed Properties in Exon Vinyl Resins

Firestone

EXON RESINS

Tool makers have discovered that EXON 654 resin improves products three ways.

First, dip-coating all-metal tool handles into a plastisol based on EXON 654 protects the handles from active corrosion. Secondly, it helps eliminate the cold "clammy" feeling tool users find objectionable. Thirdly, it insulates the user from accidental electric shock.

This is another example of how Exon's Pin-Pointed Properties match your particular needs. Dip-coating is only one way manufacturers use this versatile resin. You can spread coat it, slush mold it or foam it.

EXON 654 is just one of the many Exon resins in industry's most complete line of versatile vinyls. It is another reason why industry looks to Firestone Exon for engineered answers to its needs.

Consider your production problem. Then, for resin properties pin-pointed to the best solution for you, check Firestone.

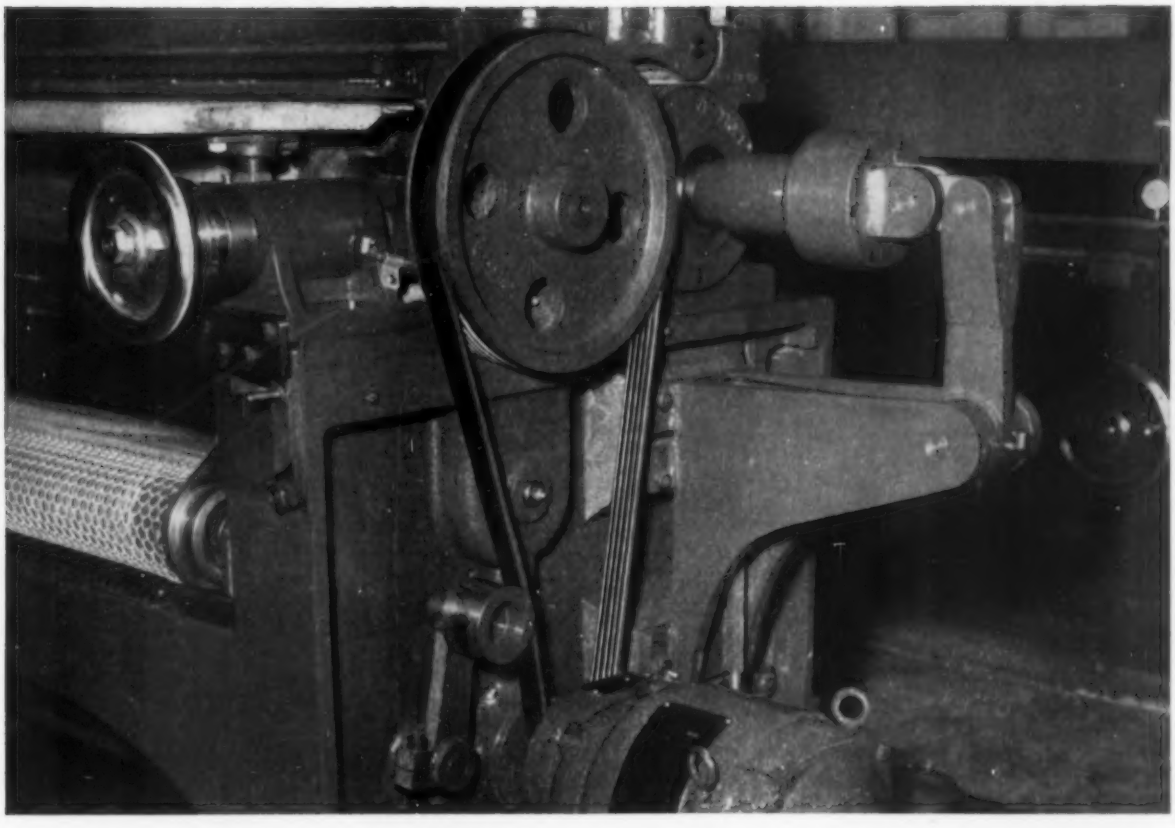
For complete information and technical service, call or write:

CHEMICAL SALES DIVISION: FIRESTONE PLASTICS COMPANY

DEPT. 76G, POTTSTOWN, PA. • A DIVISION OF THE FIRESTONE TIRE & RUBBER CO.

IN CANADA, CONTACT CHEMICAL SALES DIVISION, FIRESTONE TIRE AND RUBBER COMPANY OF CANADA LTD., HAMILTON, ONT.

INDUSTRY'S MOST COMPLETE LINE OF VINYLS ENGINEERED TO YOUR SPECIFIC NEEDS



HERE'S THE IDEAL DRIVE FOR SPACE SAVING DESIGN

. . . R/M *Poly-V*® *Drive!*

Space-saving advantages of this completely new concept in heavy duty power transmission can mean improved drive design for a wide variety of applications.

On this buffer drive, for example, installation of patented Poly-V Drive reduced sheave width 50%! Bonus advantages? *Faster* machine operating speeds, 20% lower drive costs . . . and elimination of costly "chatter" marks on textiles, leather and other materials caused by V-belt slap during buffing operations.

R/M Poly-V Drive employs a *single, endless* parallel V-ribbed belt running on sheaves designed to *mate precisely* with the belt ribs. Flat belt strength and simplicity *plus* the positive V-groove grip of V-belts gives Poly-V Drive *twice* the tractive surface of multiple V-belts of equal width . . . up to 50% more *power delivery* in the same space as a V-belt drive, or *equal* power in as little as ⅔ the space! There's less shaft overhang, too . . . less drive weight to meet heavy duty requirements.

Poly-V's single unit design also eliminates belt matching problems, greatly increases the life expectancy of both belts *and* sheaves, maintains more constant speed ratios under *all loads*. Just *two* cross sections of Poly-V Belt meet *every* heavy duty power transmission requirement—R/M Poly-V Drive cuts costly belt and sheave inventories to a new low!

Let the R/M engineers who developed this amazing drive help you determine the installation that will mean "More Use per Dollar" for the equipment you design or the equipment you use. Contact the R/M representative nearest to you . . . or write for Poly-V* Drive Bulletin #6638.

**Poly-V is a registered Raybestos-Manhattan trademark.*

RM735

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

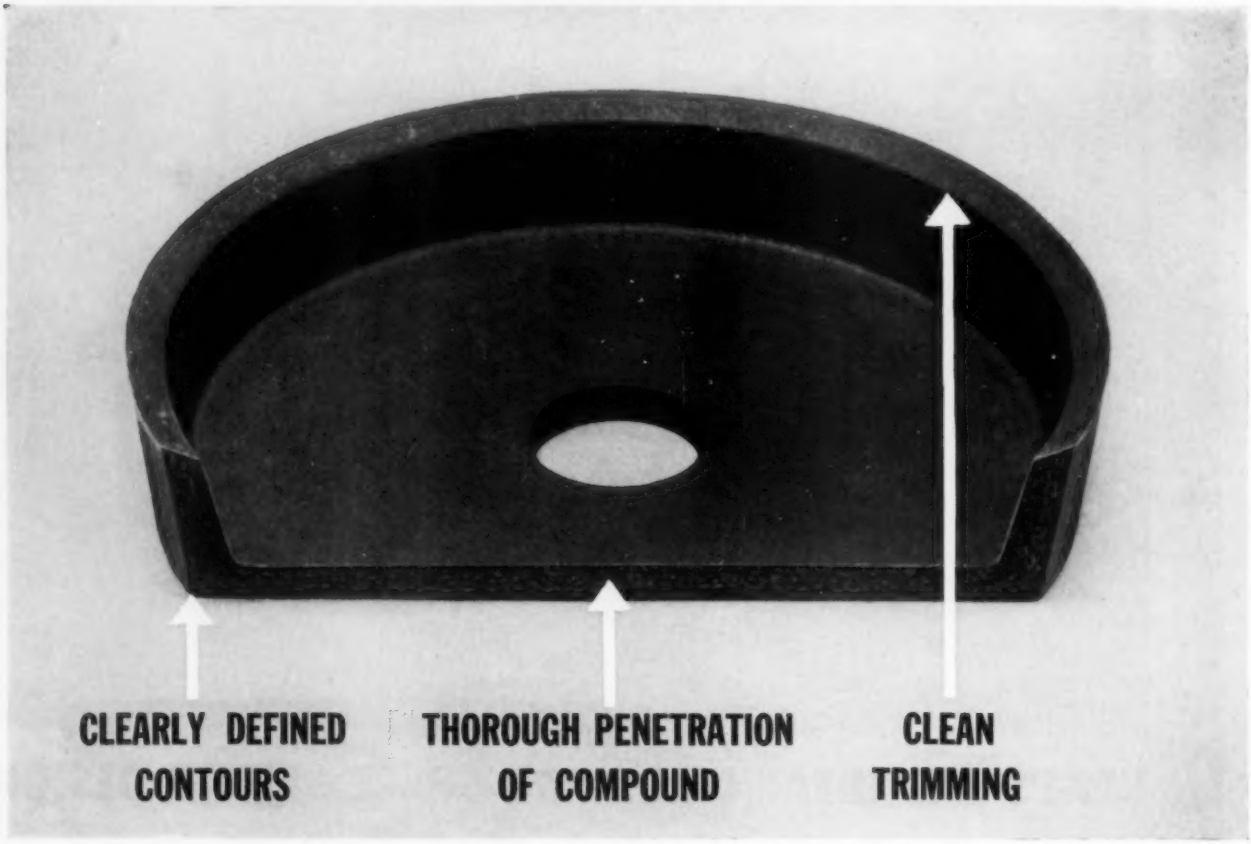
R/M

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

CALL ON R/M ENGINEERING SERVICE



MAKE THIS TEST AND SEE WHY R/M FABRIC PISTON CUPS ARE SO LONG WEARING

Cut into an R/M Fabric Piston Cup and you will see how R/M's special impregnation method results in deep, thorough penetration of the compound into the fabric. This keeps wicking action from attacking the cup internally and gives superior resistance to ply delamination. The result is extra performance and longer wear.

Another feature you notice immediately about R/M Fabric Piston Cups is their clean outward appearance. Clearly defined contours, smooth surfaces, and precision trimming all show superior molding practice.

Equally important, R/M's careful quality control assures dimensional uniformity, consistent hardness, and strict adherence to industry standard sizes.

R/M Fabric Piston Cups are available to fit hydraulic and pneumatic cylinders of from ½ to 12 in. diameter. Cups are furnished in varying degrees of hardness for pressures up to 1500 psi and in different compounds to meet specific operating conditions.

For booklet shown, or other data, write, phone or wire:

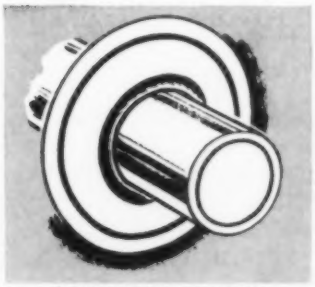
PACKING DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J. • GRegory 3-2000

R/M

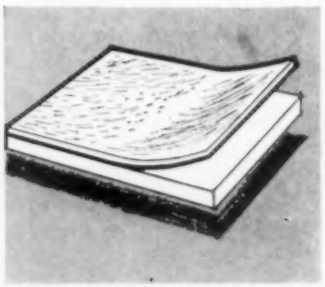
SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings | Mechanical Packings and Gaskets | Abrasive and Diamond Wheels | Industrial Drive Belts | Industrial and Automotive Hose | Conveyor Belts

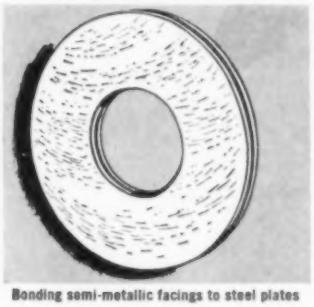
FOR HELP IN SOLVING YOUR PROBLEMS



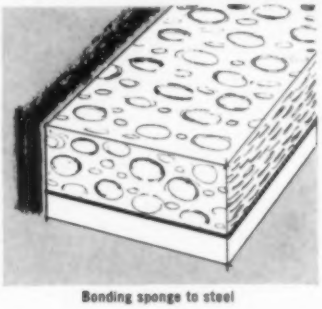
Sealing solenoid valve assembly



Bonding asbestos shim stock to vinyl plastic



Bonding semi-metallic facings to steel plates



Bonding sponge to steel

R/M Ray-BOND® ADHESIVES
simplify product design, cut costs

R/M adhesives, protective coatings, and sealers extend the horizons in the design of new products of all kinds. As in the products shown here—and in countless other applications—they bond parts together, help build stronger, more durable assemblies and, in addition, help reduce production costs.

R/M Ray-BOND adhesives, compounded of synthetic or natural rubber, resin bases of many types, and combinations of rubber and resins, have excellent bonding qualities and great resistance to heat. They are suitable for bonding diverse materials such as wood, glass, cork, plastics (including "Teflon"*), friction materials, metals and countless others. They resist temperature extremes ranging from −80°F to 700°F.

*A Du Pont trademark

For booklet shown, or other data, write, wire or phone:

Adhesives Department
RAYBESTOS-MANHATTAN, INC.
Bridgeport, Conn.

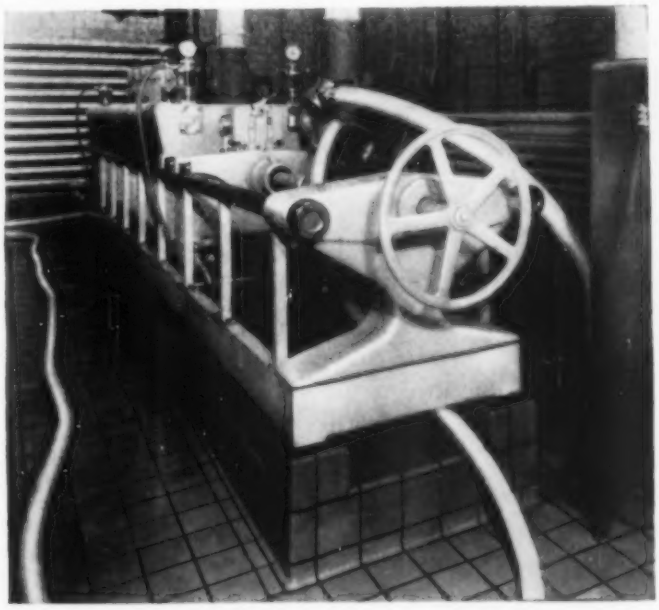
ENGINEERED RUBBER HOSE

R/M makes rubber hose for *every* application. Usually one of the R/M exclusive constructions will fill your requirements. Homoflex is a lightweight, easy handling hose with rope-like flexibility—ideal for use with air tools and water. Allflex is a versatile all-purpose hose for handling air, water, oil, gases and mild chemicals. If you need special constructions, R/M makes them all . . . for acids, chlorine, sandblast or contaminating chemicals. Special burst-resisting types with flexible wire insertion are made for safer service with high pressure air and steam. If you have metal piping wear, corrosion or expansion problems, use Condor Flexible Rubber Pipe or Manhattan Expansion Joints. Whether your design calls for hose, transmission or conveyor belts, V-belts, Poly-V* Drives, or molded rubber products, you can depend on R/M.

*Poly-V is a registered Raybestos-Manhattan trademark

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J. • GRegory 3-2000



RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

Industrial Adhesives

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

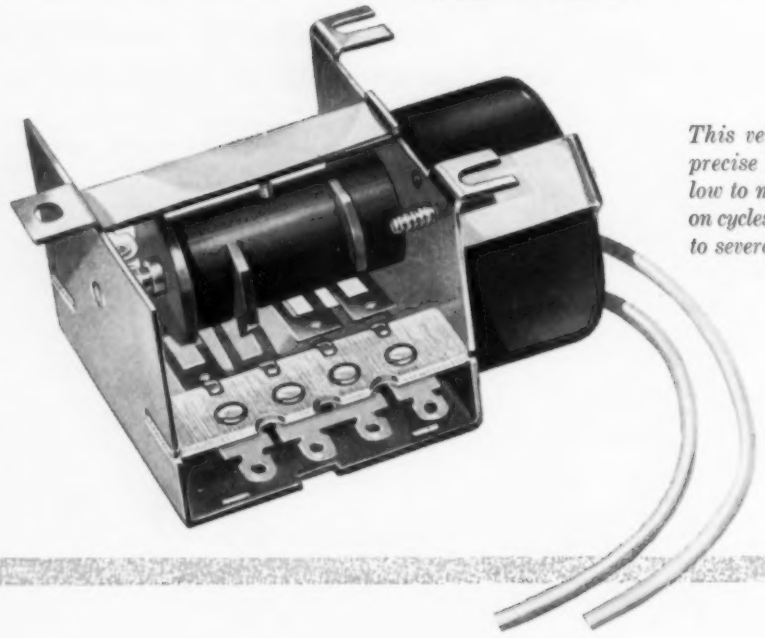
R/M

WHICH of these Actuation Problems are YOURS?

☐ SPACE/WEIGHT

☐ PRECISION

MALLORY



This versatile switch provides precise control of numerous low to medium power circuits, on cycles ranging from 1 second to several hours or longer.

Precision switching on long or short cycles... with Versatile New Mallory Timer

THIS is one of the most versatile timer switches that Mallory specialists have designed. Originally conceived as a short-cycle timer for automatic vending machines, it is now available in many modifications that fit the needs of short to long cycles in numerous low to medium power uses—in appliances, and scores of other products powered by fractional horsepower motors.

PRECISION TIMING. The combination of a constant speed permanent magnet motor and contact action by sharp cam rise gives highly accurate timing. On a 7½-second cycle, for instance, accuracy of ±20 milliseconds is guaranteed.

MOTOR RESET eliminates uncertainty and inflexibility of mechanical spring flyback at end of cycle.

MANY VARIATIONS of the basic design are readily available at economical cost. Numerous circuits can be handled. For example, one version of the timer controls five circuits, one of which is motor reset . . . or 6 circuits if the full potential accuracy of the timer is not required. The precision-timed portion of the cycle can be made adjustable by a variable cam. Tooling is also available for direct adjustment of this part of the cycle, by means of a screwdriver vernier accessible through the end plate of the housing. Total cycle time can be anywhere from 1 second to several hours or more.

HIGH DEPENDABILITY. There are few moving parts. Silver contacts, Underwriters' Laboratories approved, have long life beryllium copper springs.

Standard a-c ratings are 10 amperes, 125 volts and 5 amperes, 250 volts. Other ratings are possible.

For complete data, and for a consultation by Mallory specialists in timer switch applications, write or call us today.

Expect more... Get more from

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical — Capacitors • Rectifiers • Mercury Batteries
Metallurgical — Contacts • Special Metals • Welding Materials

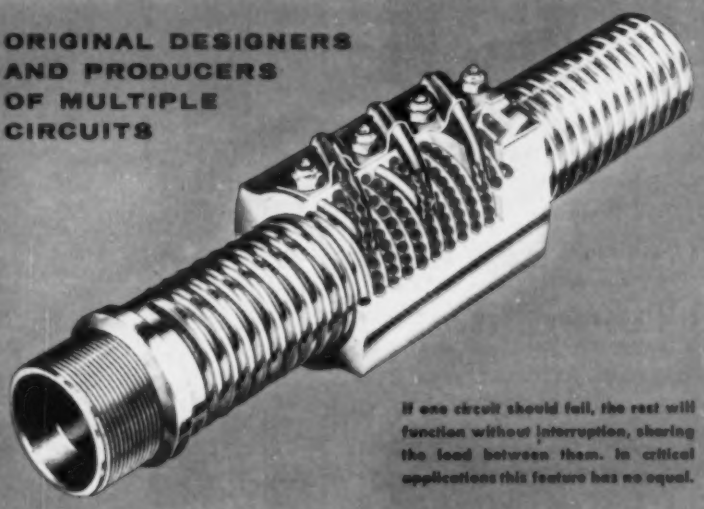
P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

WHICH of these Actuation Problems are YOURS?

- ☐ POWER CONSUMPTION
- ☐ SPACE/WEIGHT
- ☐ PRECISION
- ☐ TEMPERATURE
- ☐ LUBRICATION
- ☐ DEPENDABILITY

SAGINAW b/b SCREWS will help you solve them!

ORIGINAL DESIGNERS AND PRODUCERS OF MULTIPLE CIRCUITS



If one circuit should fail, the rest will function without interruption, sharing the load between them. In critical applications this feature has no equal.

6 BASIC DESIGN ADVANTAGES

1. Vital Power Savings. Permit much smaller motors with far less drain on electrical system, simpler circuitry.

2. Space/Weight Savings. Screws themselves are smaller, lighter; permit smaller motors and gear boxes; eliminate auxiliary equipment required by hydraulics.

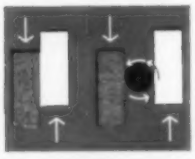
3. Precise Positioning. Machine-ground type will position components far more precisely than hydraulics or pneumatics; tolerances on position are held within .0006 in./ft. of travel.

4. Temperature Tolerance. Normal operating range from −75° to +275° F.; in selected materials, will function efficiently at temperatures as high as +900° F.

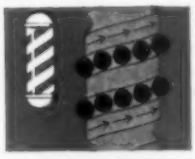
5. Lubrication Latitude. If lube fails, will still function with remarkable efficiency. Units have been built and qualified for operation without lubrication.

6. Fail-Safe Performance. Far less vulnerable than hydraulics; Gothic-arch grooves, yoke deflectors and multiple circuits provide added assurance against failure.

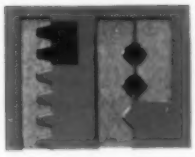
Here's why they're 90% efficient, save 4/5 on torque:



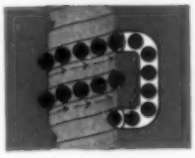
Let's start at the beginning, with the familiar principle that there's far less friction in *rolling* than in *sliding*. By applying this principle,



Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



the *Saginaw ball/bearing Screw* radically increases the efficiency of rotary-to-linear motion (and vice versa). Instead of *sliding*, mating surfaces *glide* on rolling steel balls.

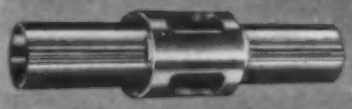


At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

Available in custom machine-ground and stock rolled-thread types. Units have been built from 1½ inches to 39½ feet long—⅜ to 10 inches in diameter.

Visit Booth 122 at Design Engineering Show, May 20-23—New York City

SAGINAW b/b SPLINE



This revolutionary new kind of spline utilizes the same basic principle pioneered by Saginaw in the ball bearing screw.

It permits new engineering designs never before practical—literally lets you achieve the "impossible"! In any application where column length must change under torque load, the Saginaw b/b Spline offers greatly decreased friction, less wear, longer life, more dependable operation. It can be fitted with integral gears, clutch dogs, bearing and sprocket seats or a wide choice of other attachments for use with electric, hydraulic or pneumatic units. To convert push-pull to rotary motion, ballcal types are available with very high loads, ranging from 20:1 to 100:1.

Outstanding opportunities for qualified engineers

Saginaw ball bearing Screws and Splines

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN
WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

SEND TODAY FOR THIS FREE 1957 ENGINEERING DATA BOOK . . .
or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 9J, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

MORE
choice of Coolant Pumps from Allis-Chalmers

Broaches, lathes, drills, grinding and boring machines . . . whatever machine tool you build or use, Allis-Chalmers has a coolant pump that's *just right* for your application. When you specify Allis-Chalmers, you get:

1. Choice of mounting — Complete line permits *six* different mounting methods — makes your design job easier.

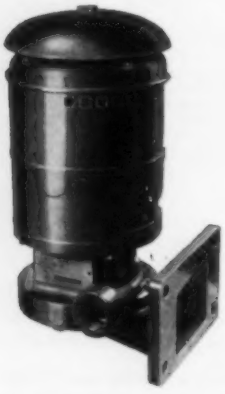
2. Choice of sealing — Depending on your requirements, you can specify mechanical seals (if clear liquids are pumped), or sealless construction (where gritty and abrasive particles are in liquid).

3. Choice of impeller — Single-suction impellers are available in either enclosed or open design—double-suction, open design.

Pump Experts from Allis-Chalmers can help you with your application. Contact your nearby A-C sales office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

MOUNTED ON DRILLING MACHINE, this A-C pump is sidewall mounted, is sealless, and has open impeller.

AVAILABLE in fractional horsepower and integral sizes, above model is designed for mounting on vertical surface.



VERTICALLY MOUNTED on liquid reservoir, this design operates efficiently with varying liquid levels. Available in four optional discharge positions.

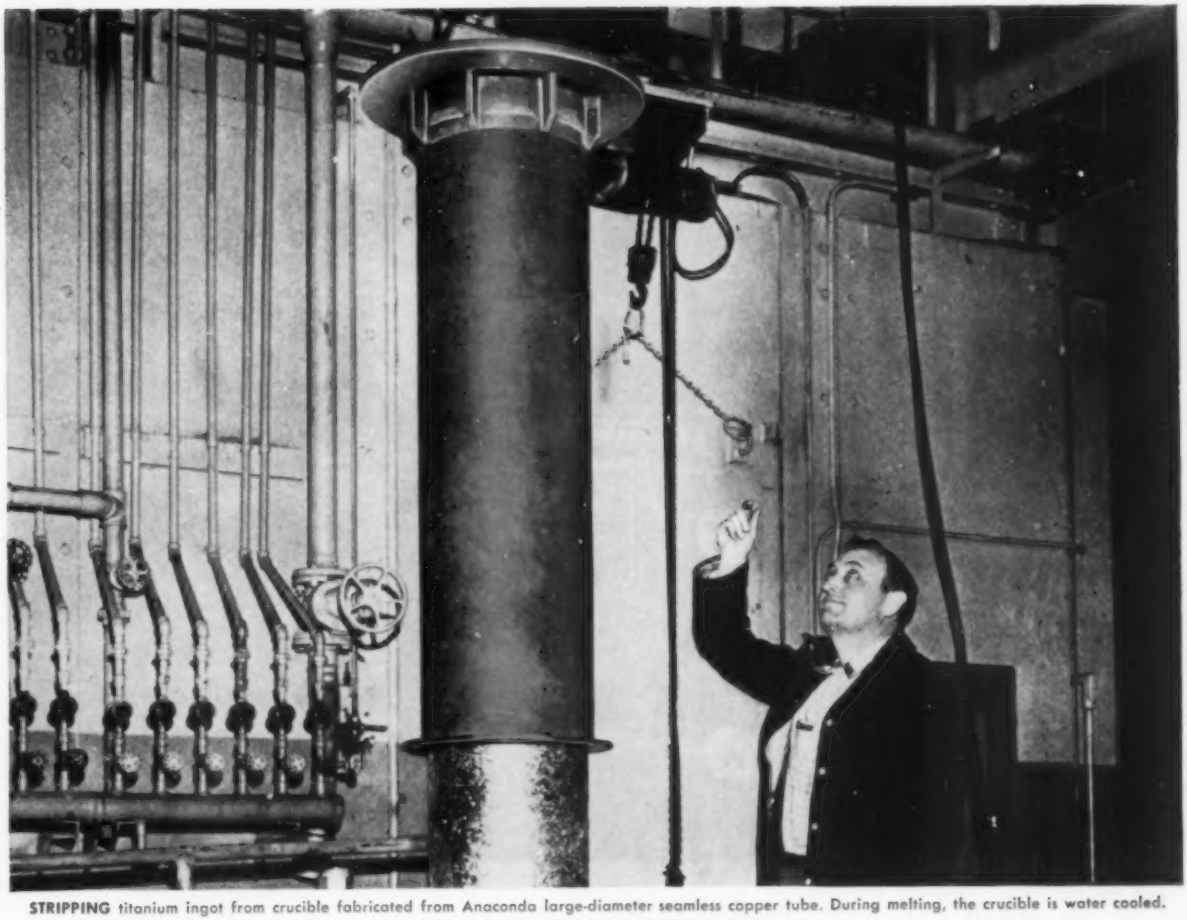
SUBMERGED MOUNTED, this type of pump is frequently used on machines requiring mounting in coolant tank.

SHALLOW SUMP or reservoir use is ideal for this submerged mounted model featuring a sealless design.

A-C ALLIS-CHALMERS

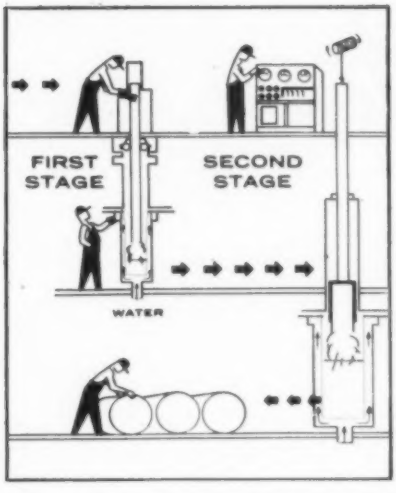
ALLIS-CHALMERS

A-5201



STRIPPING titanium ingot from crucible fabricated from Anaconda large-diameter seamless copper tube. During melting, the crucible is water cooled.

How Copper helps make superior Titanium Ingots



SPONGE TITANIUM pressed into electrodes is melted in the first-stage arc furnace, forming ingots. Several such ingots are welded together and used as an electrode in the second melting. Double melting gives homogeneous, uniform ingots. A vacuum in the crucible assures low hydrogen content.

Titanium and titanium-alloy ingots that are homogeneous and have low carbon and hydrogen content are difficult to produce. Mallory-Sharon Titanium Corp. of Niles, Ohio, however, originated the double-melting process, "Method S," for production, which does the job.

A major factor in the successful production of ingots of sound structure is the use of water-cooled copper crucibles. Mallory-Sharon found that copper met the requirements for a satisfactory crucible material, particularly because of its high thermal conductivity.

Mallory-Sharon fabricates some of its crucibles more easily and quickly, using large-diameter Anaconda seamless copper tube for the body of the crucible. Various sizes are used for the crucibles—for example 20" I.D. x ½" wall thickness; and 15¼" I.D. x ⅜" wall thickness. These big Anaconda tubes are now playing a key role in producing the ever-growing tonnage of the new structural metal so vital in the production of America's jet planes.

The American Brass Company produces the widest range of seamless tubes available to industry. At one end are tubes in copper and copper alloys up to 26" I.D. At the other are the capillary tubes as small as .032" O.D. and wall thickness of .005"—for instrument control, activating lines, and other precision purposes.

Whatever your tubing problem, see your American Brass Company representative. Or write: The American Brass Company, Waterbury 20, Conn.

5764

ANACONDA®

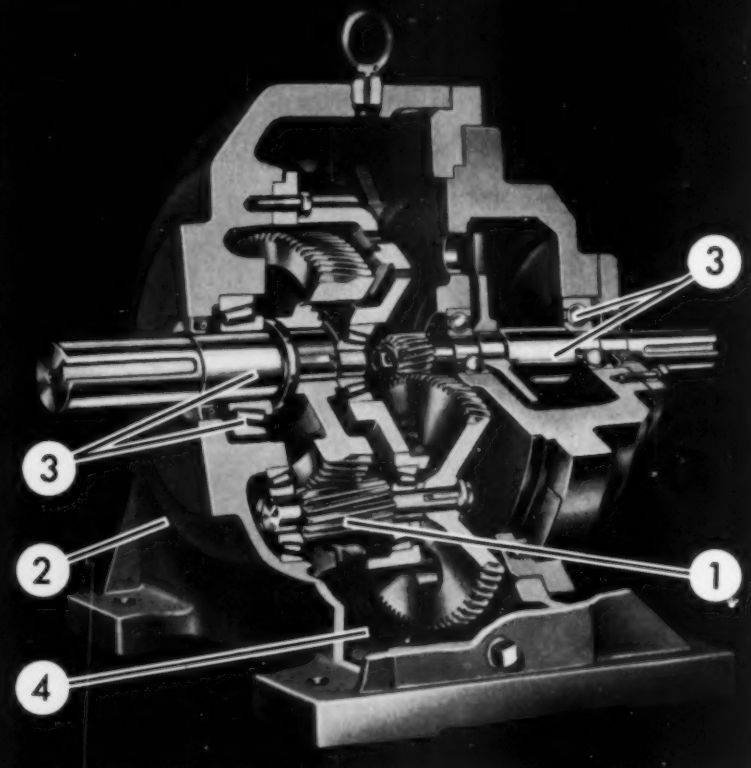
TUBES AND SHELLS in Copper, Everdur®, Cupro Nickel, Brass
Made by The American Brass Company

1. Efficient Gear Design—alloy steel helical gearing is crown shaved for optimum tooth contact; induction hardened for long life. Overall efficiency of "IN-LINE" Reducers range from 95% to 98%.

2. Rugged Housing—of corrosion resistant cast iron; designed to handle the toughest industrial service.

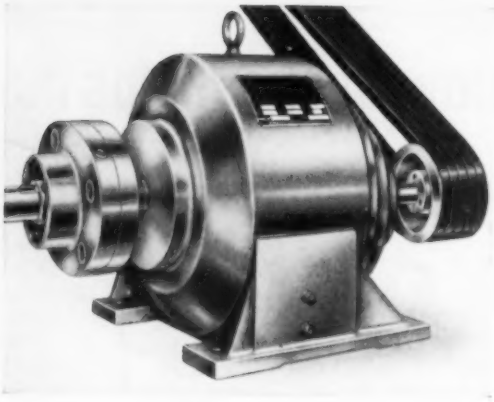
3. Large Overhung Load Capacity—is possible through the use of extra heavy bearings and shafting both on high and low speed shafts. "IN-LINE" Reducers are especially suitable for chain and V-belt drives.

4. Ample Oil Reservoir—assures maximum thermal capacity and positive splash lubrication of all gears and bearings.



Phillie Gear "in-line" reducers where mounting space is limited . . .

The streamlined compactness of these new units makes them ideal for mounting in places where space is limited. Accurately manufactured helical gearing, rugged housing construction and precision mounted shafts and bearings assure long, dependable service, with a minimum of maintenance. The *new* Phillie Gear "IN-LINE" Reducers are available in 18 different sizes and gear reductions to suit most types of service . . . they are easy to place into service and suitable for mounting in various positions. Philadelphia "IN-LINE" Reducers provide the economical solution to a wide range of power transmission problems. Standard AGMA ratios from 1.25:1 to 205:1, in capacities up to 60 horsepower . . . Send for Catalog GM-560A, which fully describes and illustrates these rugged, efficient money-saving units.



phillie gear®

PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS
Virginia Gear & Machine Corp. • Lynchburg, Va.

BEHIND THE GLAMOR, WEIRZIN® RUST PREVENTION

Production *and* product bonuses are all yours with Weirzin electrolytically zinc-coated steel, as many a manufacturer is finding out.

Take Farrington Manufacturing Co., Needham Heights, Mass., for instance—makers of jewel cases, display boxes and metal radio cabinets. "We make the shells for our cases and boxes out of Weirzin," a spokesman reports. "Its zinc coating prolongs the life and beauty of our Texol® covering materials because it retards rust formation which would cause surface irregularities. Interior rust stains in our delicate satin and velvet lining materials are eliminated. Furthermore, our adhesive bonds better to Weirzin than to plain steel.

"In the matter of die life, we have substantially increased our production of shells between grinds, thanks to the lubricating action of Weirzin's zinc coating."

Weirzin's zinc coating stands up under the most punishing fabrication steps, too. Won't chip, flake, peel; ends costly re-coating of steel parts after fabrication. And *chemically treated* Weirzin takes paints, enamels, lacquers and lithograph inks beautifully; holds them better than any other form of steel; eliminates underfilm corrosion. Investigate Weirzin's superior steel fabricating qualities and flawless rust prevention.

Write Weirton Steel Company, Dept. D-12, Weirton, West Virginia, for free illustrated booklet—"Weirzin."

WEIRTON STEEL COMPANY

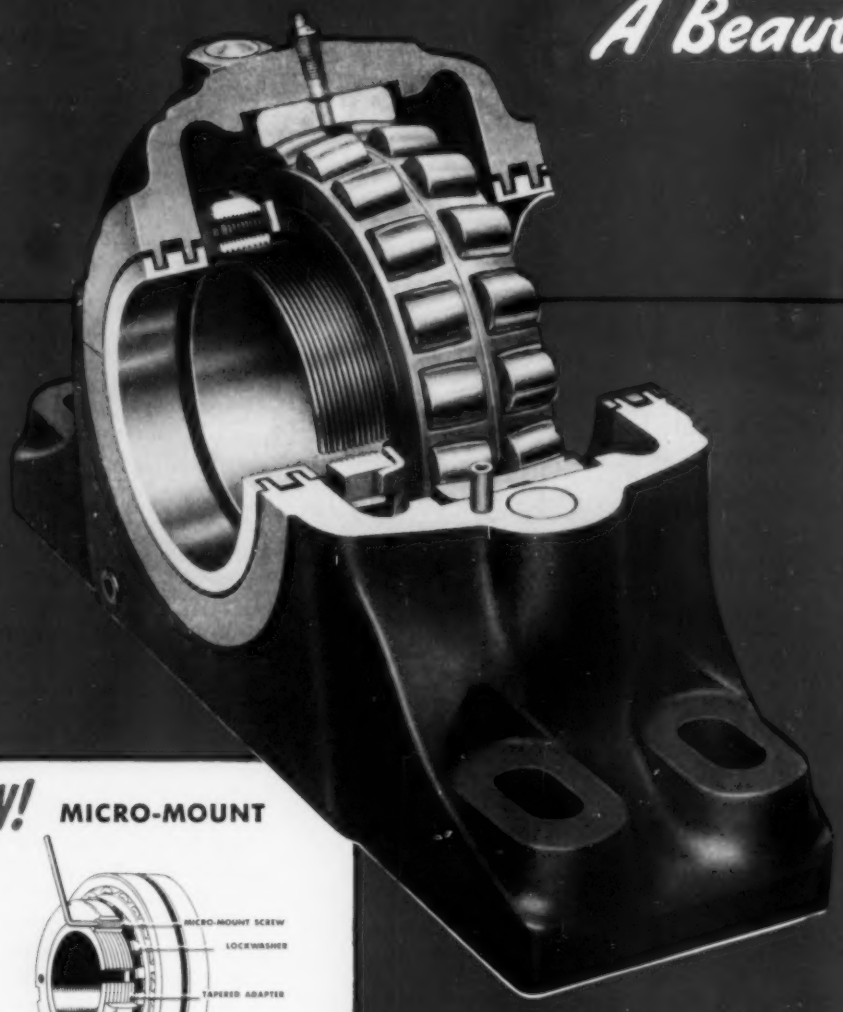
WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

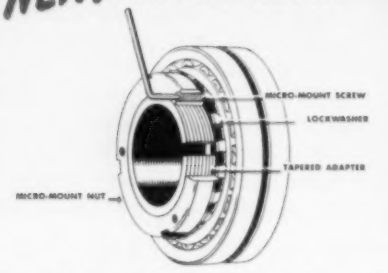
a division of

NATIONAL STEEL CORPORATION

A Beautiful



NEW! MICRO-MOUNT



Fast and accurate mounting is made possible by the new Dodge Micro-Mount. The Adapter is snugged up with the Micro-Mount Nut. Mounting is completed by turning the Micro-Mount Screws against the Lockwasher until bearing, adapter and shaft form an integral unit.

Now — a spherical roller bearing pillow block has been added to "America's most complete line of mounted bearings."

This new Dodge product possesses all the fine characteristics of the spherical type, plus the precision, dependability and refinements you would expect from the nation's leading supplier of mounted bearings.

Rugged housing of close-grained semisteel, in compact modern design, withstands shock loads. The new Micro-Mount Adapter seats Spher-Align solidly on shaft, *with amazing ease and speed.* A new feature of bearing design allows lubricant to enter at center of bearing and move outwardly along all bearing surfaces. Convenient drain plugs permit use of either grease or oil and provide for easy flushing. Triple seals retain lubricant.

Standardized dimensions make Spher-Align interchangeable with all other similar units. Available in expansion and non-expansion types. In stock for 2 7/16" to 8" shafts. Call your Dodge Transmissioneer — or write us.

DODGE MANUFACTURING CORPORATION • 1200 UNION ST., MISHAWAKA, INDIANA

New Bearing by Dodge —

Spher-Align

ANNOUNCING AMERICA'S NEWEST SPHERICAL ROLLER BEARING PILLOW BLOCK ... A RUGGED BEARING IN ATTRACTIVE MODERN DESIGN ... INHERENTLY SELF-ALIGNING ... EASY TO INSTALL ... EASY TO MAINTAIN ... AND FEATURING THE UNIQUE MICRO-MOUNT ADAPTER

AMERICA'S MOST COMPLETE LINE OF MOUNTED BEARINGS

DODGE-TIMKEN
Tapered Roller

SPHER-ALIGN
Spherical Roller

SC, SCM, SL
Ball

SLEEVOIL
Precision Ring Oiling

BRONZOIL
Capillary Oiling

BABBITTED
Solid and Split

PILLOW BLOCKS • HANGER BEARINGS
FLANGE BEARINGS • UNIT MOUNTS • TAKE-UPS

DODGE
of Mishawaka, Ind.

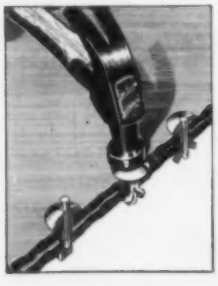
CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in the yellow pages of your telephone directory — or write us.

MANY FACTORS CONTRIBUTE TO LOW INSTALLED COST OF SOUTHCO DRIVE RIVETS . . .

ECONOMICS OF FASTENING COVERS FULL CYCLE FROM INVENTORY REQUIREMENTS TO FINISHED PRODUCT

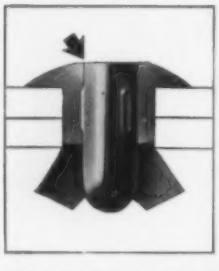
Designers who specify fasteners realize the many considerations that enter into cost determination. While ease of installation is often the most important feature, other factors affect costs. It may be difficult to put a dollar value on availability, for example, but serious financial losses do occur when production is held up or shipping dates are missed because of a slow fastener delivery. Being able to ship from stock, as Southco does, helps avoid production delays.

ELIMINATION OF SPECIAL TOOLS



Down time due to special tool failure and maintenance of special fastening tools are two fastening costs which are eliminated by Southco Drive Rivets. The only tool required is a hammer . . . any kind of a hammer . . . claw or ball, and size is not important. The number of men on a Southco riveting job is never limited by the number of special tools on hand and in working order.

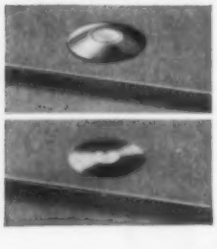
QUICKLY SET



To install, Southco Rivets are placed in drilled hole. The pin is then driven with a hammer. Installation is complete. No bucking is required.

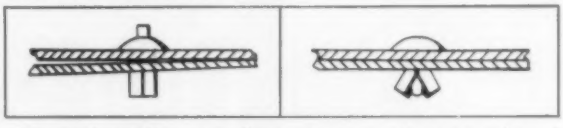
Expanded prongs force parts together. Pin is locked securely into rivet by displaced metal filling unique grooves. Compression forces are utilized for greater strength.

NO FINISHING OFF, NO WASTE



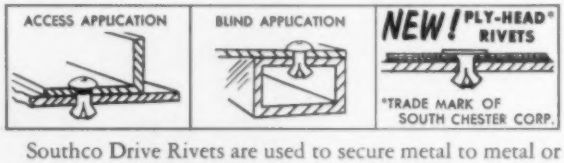
Impact of hammer seals pin neatly in rivet. No part of the rivet is cut off and discarded. No time-consuming filing, grinding or polishing is necessary. No scrap to clean up.

AUTOMATIC "PULL-UP" ACTION ASSURES TIGHT JOINT



Even when adjacent surfaces are separated, parts are forced together by Southco Rivet action, then held tightly in compression.

WIDE RANGE OF APPLICATION



Southco Drive Rivets are used to secure metal to metal or metal to wood. They are equally adaptable to blind or open applications. In each, they are quickly set and grip tightly. New PLY-HEAD* rivet permits higher loading of "soft" materials such as plywood, plastics and composition.

AVAILABLE IN ALUMINUM OR STEEL

Southco Rivets are supplied in aluminum or cadmium plated steel. The aluminum rivets have either cadmium plated or stainless steel grooved pins. The steel rivets have cadmium plated steel grooved pins.

Standard head designs are Universal or Countersunk. Full Brazier heads are available in popular sizes. New PLY-HEAD rivet rounds out line.

ALUMINUM

DIAMETERS	LENGTHS	NOMINAL GRIPS
1/8"	1/8" to 1/2"	1/32" to 13/32"
5/32"	7/32" to 3/4"	1/16" to 5/8"
3/16"	1/8" to 3/4"	1/32" to 5/8"
1/4"	7/32" to 3/4"	1/16" to 5/8"

STEEL

DIAMETERS	LENGTHS	NOMINAL GRIPS
1/8"	1/8" to 1/2"	1/32" to 13/32"
3/16"	1/4" to 3/4"	3/32" to 5/8"
1/4"	1/4" to 3/4"	3/32" to 5/8"

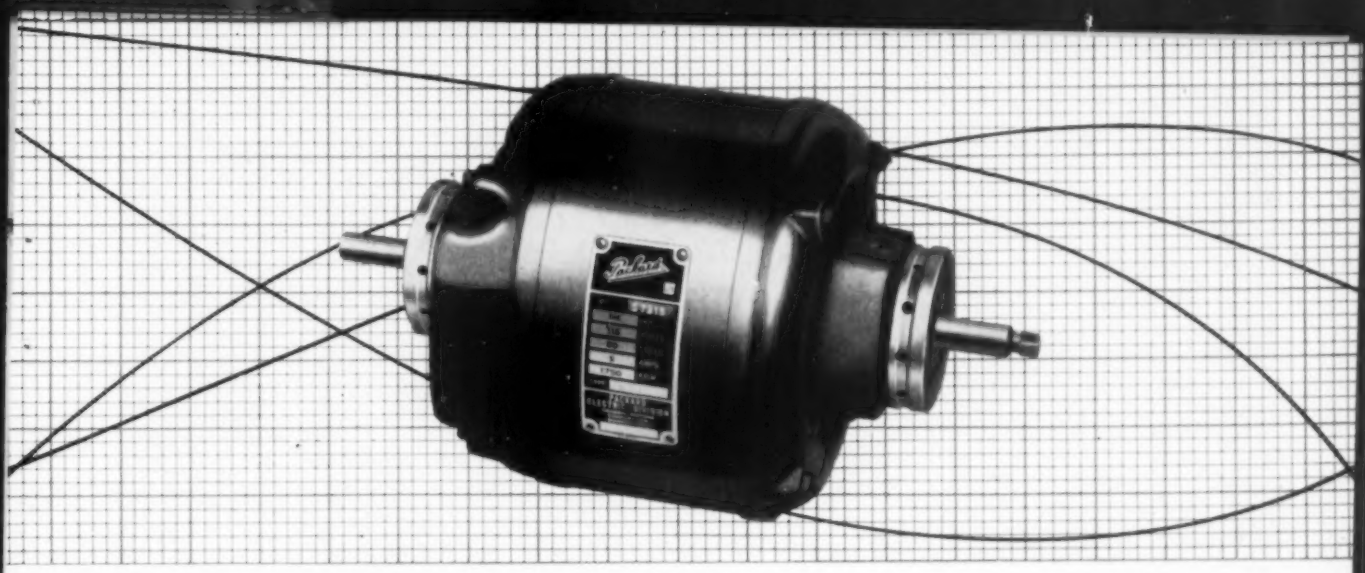
FREE FASTENER HANDBOOK . . . Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other specialty fasteners. 52 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

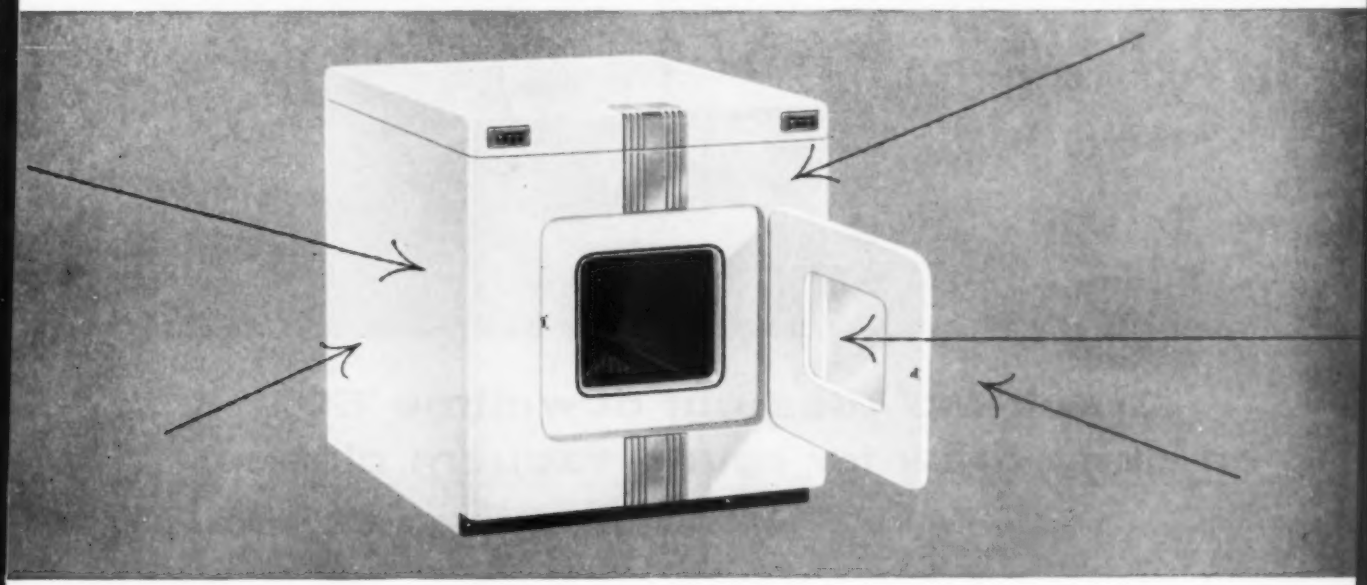
SOUTHCO FASTENERS

©1957

LION



PACKARD ELECTRIC / *Because this motor was custom-tailored*



FHP MOTORS / *this dryer is built better at lower cost!*

Packard Electric direct factory sales and engineering contact consistently pays off. In this case it did for a dryer manufacturer.

The payoff came in a motor custom-tailored to dryer requirements . . . not merely a conveniently adapted motor. This means that the motor has the exact characteristics—speed, power and torque—for its job. Because of that, it could be advantageously priced.

What's more, it can be supplied with power supply cord already attached—complete and ready for installation. This results in still more savings.

Packard Electric research and engineering teams are busy today developing new motors. And as always, our objective is to enable customers to produce better, lower priced products in the future.

Packard | *Electric*

Warren, Ohio — GM GENERAL MOTORS

Division of General Motors

Graph-Mo® dies cut downtime 50% on deep draw for round vacuum cleaner!

ENGINEERS at The Hoover Company had a tough problem in getting that round vacuum cleaner shape in the new Constellation. The two circular dies that form the hemispheres often galled, picking up bits of the steel being formed. This scored the dies, marred the finished parts. Production had to be shut down while the dies were repolished. And extra polishing of the hemispheres ran up costs still more.

After studying the problem, Timken Company metallurgists recommended dies made from Graph-Mo®—a special tool steel developed by the Timken Company. Results were outstanding. The new Graph-Mo dies cut downtime 50%. The combination of free graphite particles and diamond hard carbides in its structure make it outwear other tool steels 3 to 1. Production rolled smoothly and refinishing time was cut.

Graph-Mo machines 30% easier than conventional tool steels. And its uniform response to heat treatment eliminates distortion—saves time and money in lots of tough jobs.

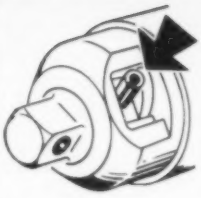
Graph-Mo is one of four graphitic tool steels developed by the Timken Company. If you would like more information about their uses in dies, punches, gages and machine parts, send for the new Timken Graphitic Steel Book. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

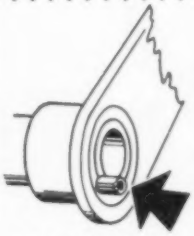
TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

Rollpin® replaces 12 different fasteners

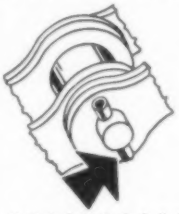


REPLACING A GROOVED PIN . . . in this application, Rollpin serves as a stop pin in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



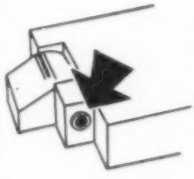
REPLACING A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than previous assemblies.

REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

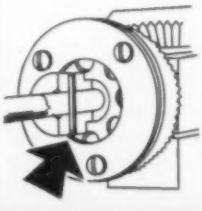


REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.

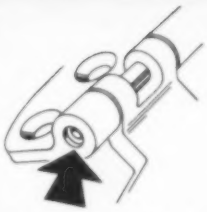
REPLACING A SET SCREW . . . to fasten automobile brake handle a short length Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft for simple handle removal.



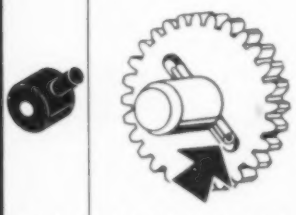
REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application shown is the plate of a home workshop tool.



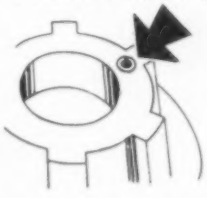
REPLACING TAPER PINS . . . in the assembly of precision differentials eliminated cost of taper pin reamers and the entire reaming operation. Rollpin costs less than a taper pin and installation is cheaper. They remove easily.



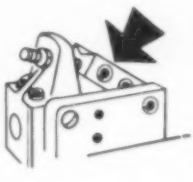
REPLACING A HEADED PIN . . . in this hinge pin application, Rollpin is simply and inexpensively driven in place, greatly reducing assembly costs. Constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.



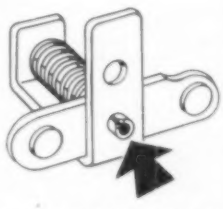
REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. This application, by an office equipment manufacturer, effects major savings in assembly. Rollpin's high shear strength is particularly valuable here.



REPLACING A DOWEL PIN . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.



REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots for the linkages in this electric welder. Rollpins may be used with a free fit in outer or inner members depending upon product design requirements.



REPLACING A RIVET . . . Rollpin serves as guide shaft for spring-loaded electrical interlock contacts. This electrical equipment manufacturer reports that rivet failure previously occurred at the clinched end under normal operating impact and vibration.

WHERE CAN YOU USE THIS SIMPLE FASTENER?

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole. Made in carbon steel, stainless steel and beryllium copper. Write for samples and information, ELASTIC STOP NUT CORPORATION OF AMERICA, 2330 Vauxhall Road, Dept. R47-52, Union, New Jersey.

ROLLPIN TRADEMARK

ELASTIC STOP NUT CORPORATION OF AMERICA
2330 VAUXHALL ROAD, UNION, NEW JERSEY

MICRO SWITCH Precision

...FIRST IN PRECISION SWITCHING

Over 200 MICRO SWITCH Precision Switches help make Lockheed's C-130 Hercules a superb military plane

Wide variety of switch types in the Hercules

Series VA Enclosed Switches
These combine the features of sealed construction and high electrical capacity. They are available with roller arm or lever actuators.

Series V3 Basic Switches
These have the highest electrical capacity for their size of any switch available. Are available in wide variety of terminal designs, contact arrangements and operating characteristics.

Series SE Sealed Subminiature Switches
These are the smallest and lightest completely environment-free precision switches available. They are built to give trouble-free operation in a temperature range of from —65°F to +212°F.

Series DT Double-Pole Double-Throw Switches
These switches simultaneously make and break two independent circuits. The double-pole double-throw switches are rated for 10 amps. 125 or 250 v ac; ½ amp. 125 v dc; ¼ amp. 250 v dc. Temperature rise limits maximum continuous current to 10 amperes per pole.

MICRO SWITCH Engineering Service cooperated with Lockheed engineers of the Georgia Division, Marietta, Ga., for five years in the designing, planning and manufacturing of this plane—the first propjet transport accepted by the U. S. Air Force.

Over 200 precision switches at strategic points perform important functions in the operation of this superb aircraft. Other MICRO SWITCH precision switches are employed in components for this plane supplied by other manufacturers. Still others provide important controls for the machine tools used in the building of the C-130 itself.

Whatever your design—be it aircraft, machine tools, or any type of industrial equipment—MICRO SWITCH components and MICRO SWITCH Engineering Service may help you make a good design even better.

MICRO SWITCH reputation for reliability, precision and performance is written in the success of such products as the Lockheed Hercules and thousands of fine industrial products. MICRO SWITCH Engineering Service is as close as your telephone. Why not call the nearest branch office today?

Switches have uses unlimited

Here's a tough switch to take the roughest going

The MICRO SWITCH sealed Type EN switch was designed to meet tough aircraft problems. Its many unusual features are now meeting many exacting industrial design requirements.

How good is this switch? Check your requirements against tests like these:

- Precise performance at minus 65°F or heated to plus 180°F. (Operating force to 20 lbs. available to facilitate ice breaking.)
- Precise performance after 100 hours in salt brine spray.
- Precise performance after hours of immersion under 36 in. head of alternating iced and heated water.
- Precise performance unaffected by 30 days' operation at 104°F and 95% humidity.
- No chattering of contacts—or loosening of parts—during vibration tests of 10 to 500 cycles per second.

(Send for Catalog No. 77)

Hermetically sealed basic switch insures constant performance

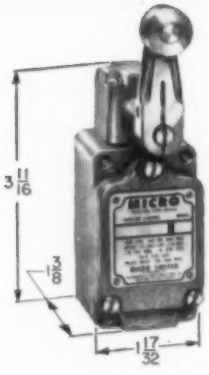
This small MICRO SWITCH Type HS precision switch is truly hermetically sealed (glass to metal and metal to metal) to insure constant operating characteristics under any environmental conditions—for example, no condensation problem.

The switch shown has a lever type actuator for inline motion operation. The switch is also available with a roller-lever actuator suitable for actuation by cams, slides or other mechanical means.

Characteristics of Switch Shown

Operating force—10 to 22 oz.; Release force—4 oz. min.; Overtravel—.010 min.; Differential travel—.020 in. max.; Weight—1.5 oz.

Electrical Characteristics—28 volts dc—inductive 10 amperes; resistive 25 amperes; 125 volts ac—inductive 1 ampere; resistive 1 ampere. (Send for Catalog No. 77)



Sealed—Reliable—Versatile—Give millions of operations

The MICRO SWITCH Type LS is a small two-circuit switch which meets a wide variety of industrial design requirements. It is extremely reliable, ruggedly housed and can be mounted in almost any location. Actuator head may be removed in the field and rotated to permit actuation from any of the four quadrants. The roller-arm actuator is field adjustable through 360°. It may operate in either direction, or one direction only.

The electrical rating is: 10 amperes 120, 240 or 480 volts ac; ½ H.P. 120 volts ac; 1 H.P. 240 volts ac; .8 ampere 115 volts dc; .4 ampere 230 volts dc; .1 ampere 550 volts dc. Pilot duty rating is 600 volts ac maximum.

(Complete information in Catalog 83)

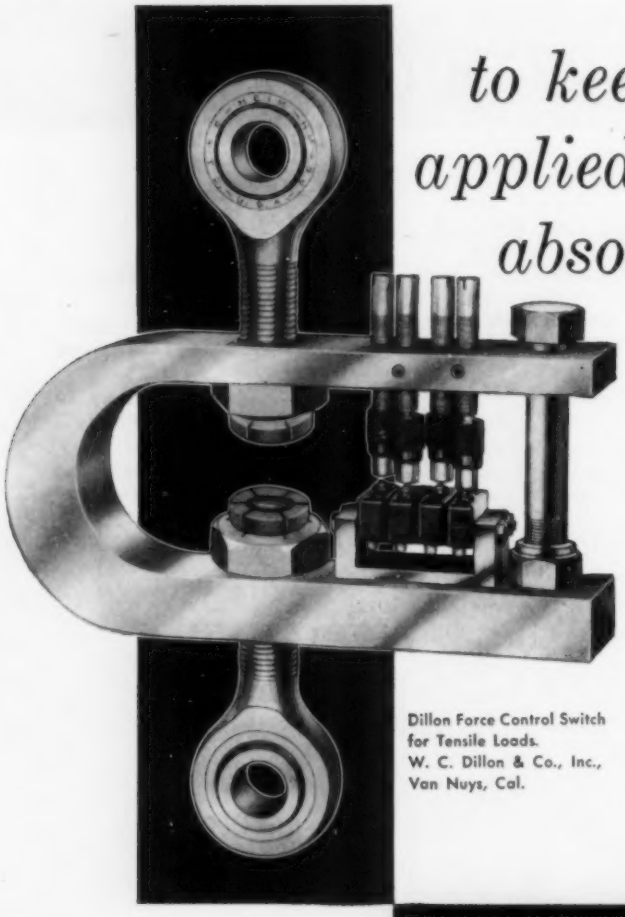
MICRO SWITCH, a Division of Honeywell, pioneered the manufacture and development of precision snap-action switches

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

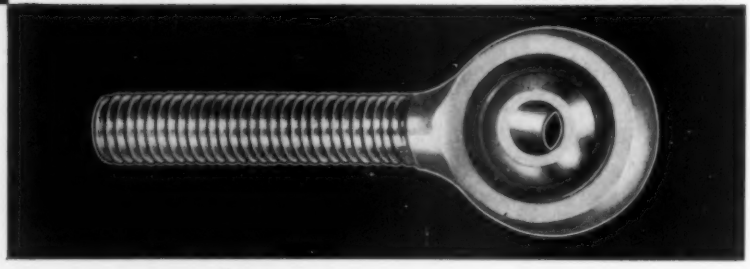
to keep the applied line of force absolutely vertical



Dillon Force Control Switch for Tensile Loads.
W. C. Dillon & Co., Inc., Van Nuys, Cal.

It is essential that applied line of force remain absolutely vertical in the popular Dillon Force Control Switch, and the best possible solution has been found in the HEIM Unibal Rod End Connector. Two of these are employed so that regardless of load angle, the actual instrument always remains straight up and down. Heim Unibal also allows the operator to adjust working length to suit available space. Dillon engineers rate them tops for critical fit, freedom from slop or wobble and for all-around quality.

Heim Unibal Male Rod End



What does the Dillon Force Control Switch do?

As many as four control switches may be mounted on one side of the open end. Directly opposite, and on the other side of the beam, are finely threaded adjustment screws, which make contact, under load, with each switch in succession or with all at the same instant. Thus, if it is necessary to trigger a series of devices at varying loads, each switch is set at the specific load. If all four devices are to be triggered at the same time, then all four switches are identically adjusted.

The Dillon Switch affords excellent overload protection for hoists and cranes, operates remote signal lamps, warning devices, etc.

The **HEIM** *Unibal* is the spherical bearing developed, engineered and manufactured by The Heim Company for over fifteen years. They correct misalignment in every direction, reduce friction, carry maximum radial and thrust loads, save time in assembling, and are usually more economical than specially machined parts.

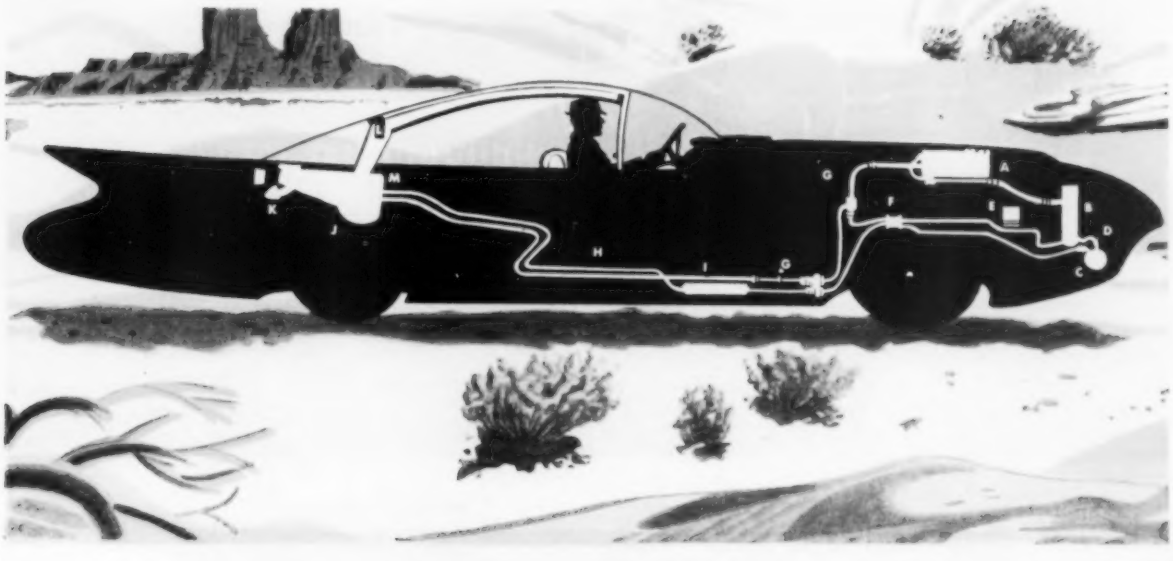
Heim Unibal Bearings are distributed nationally by qualified bearing experts. Send for the Heim Complete Catalog.

THE HEIM COMPANY / **Fairfield, Connecticut**

Naugatuck PARACRILS

Phantom view of one type automobile air conditioning system

A. Compressor
B. Condenser
C. Receiver
D. Receiver Check Valve
E. Metering Solenoid
F. Liquid Line Sight Glass
G. Flexible Connectors in Refrigerant Suction and Discharge Lines
H. Refrigerant Lines Clamped to Frame Beneath Car
I. Liquid Line Dehydrator and Filter
J. Evaporator and Blower Assembly
K. Fresh Air Intake
L. Discharge Ducts and Air Distribution Grilles
M. Return Air Grilles on Package Shelf



cool!

Air conditioning an automobile is not a new idea... just one that presented a variety of material specification problems. One of the most important of these problems was the need for a rubber with low enough permeability to be used as a vehicle for commercial refrigerants. This was solved with a Paracril® rubber.

Paracrils are Naugatuck's butadiene acrylonitrile rubbers. Rubbers capable of carrying refrigerants while possessing outstanding resistance to oils, fuels, aromatic hydrocarbons and many hydraulic fluids. In addition Paracrils provide:

- **superior aging resistance, even at elevated temperatures,**
- **high and low temperature flexibility,**
- **outstanding abrasion resistance,**
- **unusual tensile properties,**
- **the best resistance to air and gas permeability.**

For complete information on how the *oil-resistant Paracril* family can help you improve or develop a product, write to us, *today*.

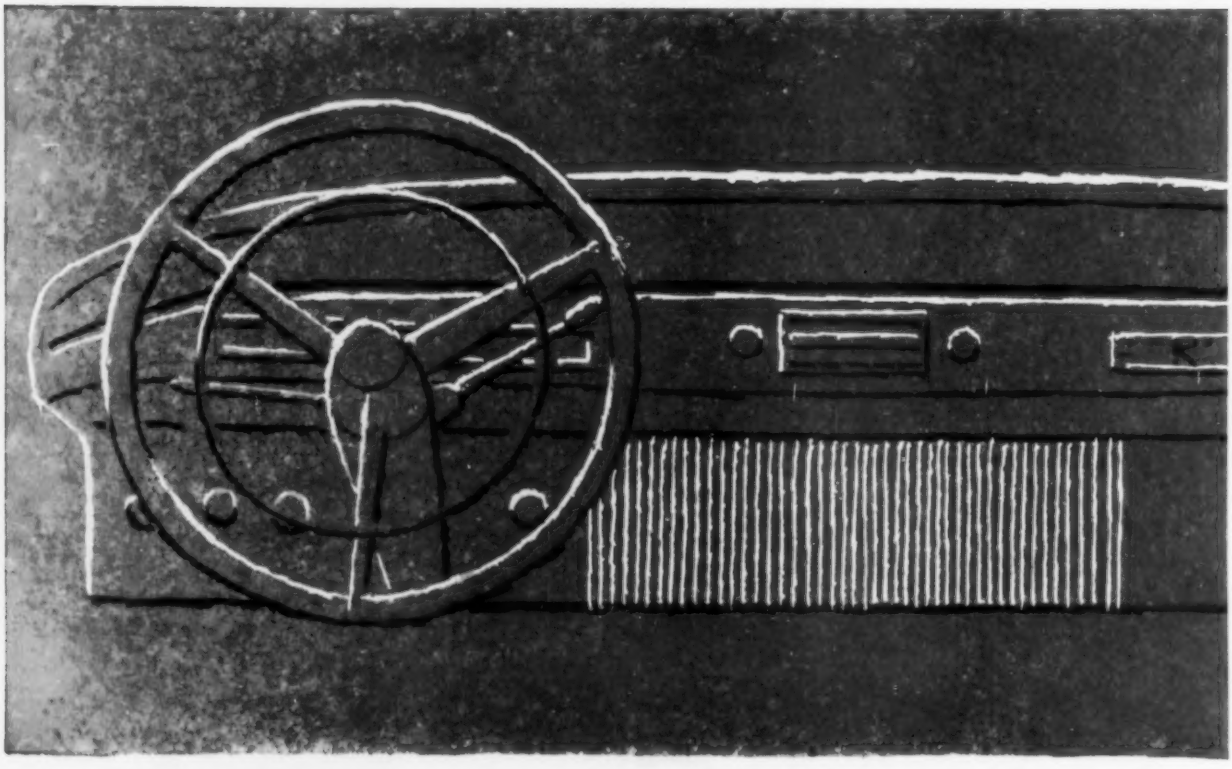
Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

US RUBBER

IN CANADA: NAUGATUCK CHEMICALS, Elmira, Ontario • Cable Address: Rubexport, N. Y
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices

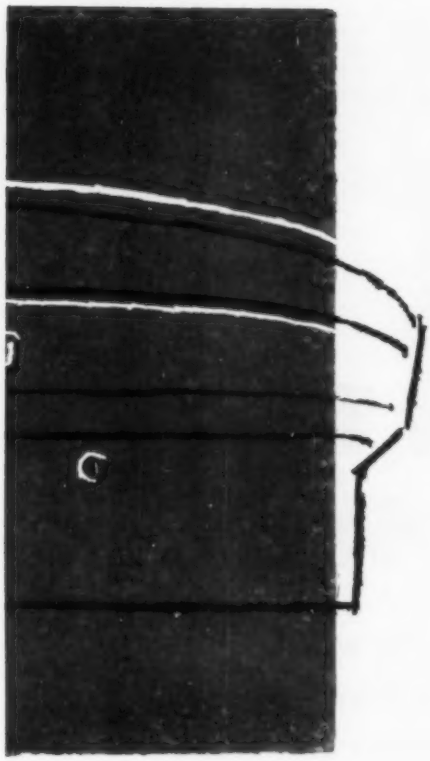
DECORATION



UNITED STATES

USS

that can't fall off, rub off, or chip off!

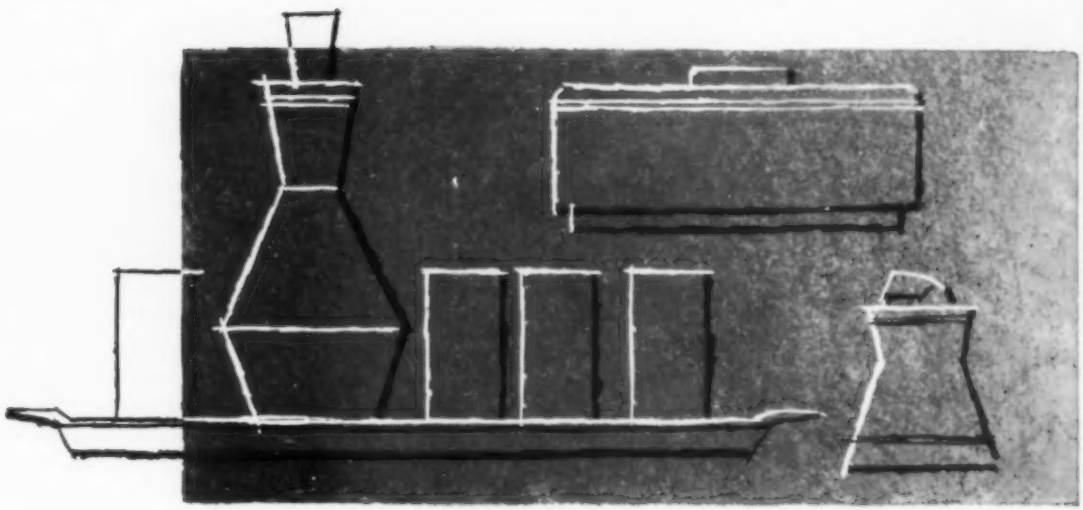


EMBOSSED STRIP STEEL

Embossed strip steel—with the pattern built right in the steel—is an exciting and salable way to decorate products of steel. It is a way to add durable texture to an automobile dashboard, distinctive pattern and design to an automatic toaster. It is a way to add permanent charm and character to hinges, escutcheons, or other hardware items.

It is the low-cost way to dress up a product, because you don't have to apply the pattern. It is right in the raw material, put in at the steel mill. And put in to stay.

Tailored to your product! Amerstrip steel—either embossed or plain—is always tailored to a specific use. You get the exact shape, finish, ductility and other characteristics that you need. As a result—you can often build a better product, more economically, by making it from Amerstrip.



Call any sales office of American Steel & Wire for more information about the availability and uses of Amerstrip in carbon, alloy, or stainless grades.

AMERICAN STEEL & WIRE DIVISION • UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

STEEL

AMERSTRIP

NOW! A Small Machine That Makes Big Prints . . . New Model 300!

It's only 46" wide, yet offers a full 30" printing width! This remarkable low-priced table top machine brings "inside" reproduction within the means of the smallest department or firm, makes an ideal "extra" machine for large companies. Handles every type of reproduction job that bigger, costlier machines do. Operates on 115 volt A.C.

Right Now Is the Time to New and Better Copyflex

NOW! A Faster, Easier-to-Use, Heavy-Volume Machine . . . Model 500!

You'll turn out more work with less operator time and effort with this new, ultra-fast machine. It offers top mechanical speed of 40 f.p.m., 46" printing width, automatic separation, front or rear delivery, automatic stacking, and a host of other advanced features. Its 4,000-watt quartz lamp and synchronized exposure and developer units assure uniformly sharp, clear prints.

Act Now to Save Time and Manpower, Meet Growing Production Boom Demands!

Now is the time to take a good look at your older reproduction equipment. If it's more than a few years old, chances are it's costing you unnecessary time and money. It may well turn out to be a bottleneck in your efforts to meet growing production boom demands.

Compare your equipment with the new, modern Bruning machines shown here. You should be getting the time and manpower savings offered by greater mechanical speeds, faster return of originals, automatic separation, front or rear delivery! You should be benefiting by problem-free installation and operation—no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection.

If you're not getting these important advantages, then every day you delay getting new, modern Copyflex is costing you time and money. Act now by mailing the coupon below. You'll be glad you did!

NOW! The Speedy, Versatile Helper Your Big Machine Needs . . . New Model 110!

When you need prints of such smaller size originals as specification sheets, check prints, and engineering changes, this handy table top machine turns them out in a jiffy without tying up your big machine. It saves you time, money, and inconvenience. It has a printing width of 11". Makes 8½ x 11 prints for less than 1¢ each for materials. Operates on 115 volt A.C.

Replace Old Equipment with Reproduction Machines!

Now! A Space-Saving, Versatile Big-Volume Machine . . . Model 250!

It takes less than a square yard of floor space, yet offers a printing width of 18½" and a fast mechanical speed of 25 f.p.m. Automatic separation and stacking, one-knob control, and an extra-large feed board simplify and speed operator's work. Operates on 220 volt A.C.

NOW! A Budget-Priced, Heavy-Volume Machine . . . New Model 35!

This low-cost machine gives you all the advantages of big volume savings and speed. It provides a full 46" printing width and up to 30 f.p.m. mechanical speed. One knob controls exposure and development, assures consistently top quality prints. Handles roll stock up to 42" wide quickly and efficiently. Operates on 220 volt A.C.

SEND FOR MORE INFORMATION TODAY!

BRUNING

Best Process! Best Machines! Best Selection of Materials! Copyflex

Offices in 38 Cities of the U. S. and Canada

CHARLES BRUNING COMPANY, INC., CHICAGO

In Canada: Charles Bruning Co. (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 53-O
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on the Copyflex process and the following machines: _____

Name _____ **Title** _____

Company _____

Address _____

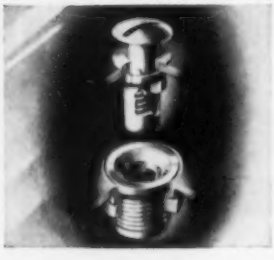
City _____ **County** _____ **State** _____

5 Simmons Fasteners offer

Economy · Quick installation · Flexibility of design ·

Whatever your application, Simmons Fasteners will fill your needs. Leading manufacturers are using Simmons Fasteners with perfect results in a wide range of products.

QUICK-LOCK



Millions in use on weather-tight lighting units, battery chargers, truck heaters, engine cowlings, access panels and doors, radio equipment covers, gas tank covers, map and data cases, transmitter cases, voltage regulators...

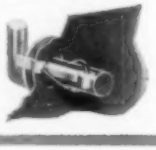
Easy to install, QUICK-LOCK is ideal for assembling removable panels and access doors. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in various sizes with choice of stud and receptacle types.

SPRING-LOCK

The perfect, proved fastener in such applications as removable covers and panels on electric and electronic equipment, railroad locomotives and diesels, all sheet-metal automobile parts, shipboard equipment, home appliances...

SPRING-LOCK, one-piece fastener for blind holes, has load-carrying steel spring wire. Spring steel arms lock it securely, prevent loosening under vibration. SPRING-LOCK is self-adjusting for various material thickness, locks with a twist of the wrist.

Plastic SPRING-LOCK Shelf Supports, with the strong "heart of steel," are available in your specified color...used by all major appliance manufacturers to cut costs, speed production, simplify servicing in refrigerators, ranges. Custom molded to your design requirements.



ROTO-LOCK

Ideal for portable Arctic region shelters, partitions, cabinets, built-ins of all kinds, desks, tables and other demountable furniture, knock-down shipping boxes, demountable refrigeration units, caskets, point-of-sale display assemblies...

ROTO-LOCK makes butt or right-angle joints easily. Tapered cam design permits secure locking even in misaligned or semi-open position. Carries heavy tension and shear loads; can be used for air and water-tight seals. Solidly built without springs or delicate mechanical parts; unaffected by sub-zero temperatures.

you every advantage...

Strength · Positive locking · Smooth fastening action

LINK-LOCK

Available in 3 sizes—heavy, medium, light duty. The perfect latching device where positive or heavy locking pressures are necessary, and where lock will have to withstand rough service. Proved in portable aircraft hangar construction, containers, military transit cases, instrument cases...

The springless latching device for use wherever pre-loaded closure is required. *(Also spring-loaded. See below.)* Impact and drop-resistant, LINK-LOCK provides heavy fastening pressure and high load-carrying capacity. Excellent for water and pressure-tight sealing. Withstands 70-below temperatures.

New! Spring-Loaded LINK-LOCK...medium and heavy duty...ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces.

DUAL-LOCK

An absolutely vibration-proof, impact-proof high-load fastener that will not accidentally unlock or loosen...ideally suited for demountable structures, guided missile assemblies, shipping containers, aircraft cowlings and sheet metal guards, and all butt-joint fastening...

Double-acting take-up in DUAL-LOCK insures heavy closing pressure with minimum pressure on operating tool. Trigger action of DUAL-LOCK assures full open and closed positions. Can be recessed in panels or surface mounted. Withstands 7000-lb. tension, and can be readily modified for light load applications.

Send today for your copy of the 40-page Simmons Fastener catalog, which gives specifications, applications, installation instructions. Samples of all Simmons Fasteners are available.

SIMMONS
FASTENER CORPORATION
North Broadway, Albany 1, New York

Visit Our Exhibit, Booth 528
1957 Design Engineering Show, New York Coliseum, May 20-23

a FRETTING-CORROSION problem had him in a spin

Finding a wear-resistant coating for turbine engine shaft seals posed a serious problem for an aircraft engine manufacturer. Even the hardest alloys were subject to fretting corrosion and had to be replaced after a few hours of service.

This fretting-corrosion problem was solved by having the bearing surface of the seal Flame-Plated by LINDE. By this special detonation process, particles of tungsten carbide are literally *blasted* onto almost any metal surface. Most important, the temperature of the part being plated never exceeds 400° F., so there is little chance that the base metal will warp or that its metallurgical properties will be changed. Flame-Plated tungsten carbide coatings can be applied in thicknesses from .010 to .002 inches. Coatings can be used in the as-coated condition (125 microinches rms) or ground and lapped to a 0.5 microinch finish.

If your design involves metal parts subject to extreme wear, heat, or fretting corrosion, perhaps Flame-Plating can eliminate some or all of your "headaches"—or make possible some completely new idea.

To find out, write us about your wear problem or request a free copy of LINDE's booklet, "Flame-Plating," F8065. Address Flame-Plating Department.

Flame-Plating by Linde

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, New York

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corporation

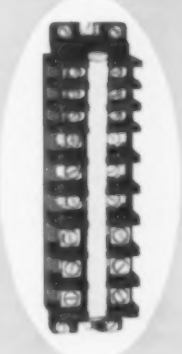
50% MORE TERMINALS IN THE SAME SPACE!

SQUARE D's *NEW* TERMINAL BLOCKS

MORE FLEXIBILITY, TOO!

NOTICE *(above)* how little space is required to remove or add a Square D channel-mounted terminal block to the completely assembled unit. Especially important for a quick change when an additional terminal must be inserted into grouping.

LOOK *(at right)*... all sizes can be mounted on same channel...25 ampere pressure wire connectors, 25 to 50 ampere box lugs ...all can be interlocked together. Terminals in kit form to "do-it-yourself" or factory-assembled to standard specifications.



SEE *(below)*...there is only one perforated channel required for either weld or screw-on mounting...available in standard lengths that can be cut "on the job" to fit any length requirement. Eliminates stocking various sizes.

ASK YOUR SQUARE D FIELD ENGINEER
or write for Bulletin which covers details on Channel-Mounted Terminal Blocks. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.

NOW...EC&M **PRODUCTS ARE A PART OF THE SQUARE D LINE**

SQUARE D COMPANY

A Boeing B-47 Stratojet medium bomber gets a take-off assist from 30 Phillips Petroleum Company M15 JATOs.

N-A-X HIGH-TENSILE is readily formed and welded. Here, before welding, a worker sizes the container's aft head, drawn by a 250-ton press. Bottom forging is locked in.

N-A-X HIGH-TENSILE STEEL FORMS AND WELDS READILY

Formability: Even at the higher strength levels (50% greater than mild carbon steel) this material can be cold formed and drawn into very difficult stampings and cold formed shapes.

Weldability: Its weldability by any process is excellent, maintaining toughness through a wide range of temperatures. Under-bead cracking tests are excellent. Using American Welding Society standard bead-weld testing, shows under-bead hardness rises only to 95 Rockwell from 80-85 Rockwell prior to welding.

Make *your* product better, too—
with this high-strength steel

How N-A-X® HIGH-TENSILE STEEL

supplied the money-saving answer to a critical take-off problem

JATO rockets boost heavily laden planes into the air faster, let them operate from shorter runways. A new JATO developed by Phillips Petroleum Company required a case that would endure a pressure of 1,000 pounds per square inch at the high blast temperatures. Yet it must be lightweight, easily fabricated, economical.

In 1954, 100 JATO cases of N-A-X HIGH-TENSILE steel were tested at Air Force Plant 66 near McGregor, Texas, where Phillips Petroleum is contractor-operator.

Result: The N-A-X HIGH-TENSILE case passed every test with flying colors. It *surpassed* the required standards for strength by as much as 20 percent.

The high-strength characteristics that make N-A-X HIGH-TENSILE a better steel for JATO fuel containers also make it better for many other types of pressure containers, where high strength and lighter weight are equally important. It is particularly suitable for Propane cylinders and pressure vessels for the chemical, automotive and oil industries, that must withstand severe interior pressures and handling abuses . . . and for such products as truck and trailer frames, wheels and bumpers, railroad and earth-moving equipment, shipping containers, pipe, and many others.

Other Important Advantages: N-A-X HIGH-TENSILE STEEL, compared with carbon steel, is 50% stronger • has high fatigue life with great toughness • is more stable against aging • is more resistant to atmospheric corrosion. It polishes to a high luster at minimum cost • has greater resistance to abrasion or wear • offers greater paint adhesion.

With N-A-X HIGH-TENSILE you can design longer life, strength with lightness, and economy into your products. Let us show you how.

COMPANION HIGH-STRENGTH STEEL IN THE N-A-X FAMILY

N-A-X FINEGRAIN. A low-alloy high-strength steel ideally suited for applications where the enhanced resistance to atmospheric corrosion of N-A-X HIGH-TENSILE is not required.

N-A-X
HIGH-TENSILE STEEL

N-A-X Alloy Division
GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan — Division of
NATIONAL STEEL CORPORATION

N-A-X Alloy Div., Dept. C-1
Great Lakes Steel Corp., Detroit 29, Mich.

☐ Please send me 8-page illustrated technical catalog on N-A-X HIGH-TENSILE Steel.

☐ Please have your representative contact me.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

Wherever your machinery is shipped...

the performance and the name are the same around the world!

FOR YEARS SHELL TELLUS OIL has been top-rated as both a lubricant and a control fluid for complex hydraulic systems. Its ability to combat foaming, oxidation, rust, sludge-formation and wear has earned it nation-wide popularity.

You may be glad to know that the equipment you manufacture can get the same efficient protection in foreign countries. Tellus* Oil is available to your foreign customers from near-by points. It will be the same Tellus Oil that your domestic customers rely upon. Write Shell Oil Company, 50 West 50th St., New York 20, New York, or 100 Bush Street, San Francisco 6, California.

*Trademark

Machinery manufacturers:

Your customers abroad will receive the same Shell Tellus Oil that your domestic customers enjoy. And this same uniformity applies to

SHELL TURBO OIL—gives anti-wear lubrication for utility, industrial and marine turbines

SHELL ALVANIA GREASE—multi-purpose industrial grease, and a complete line of other

SHELL INDUSTRIAL LUBRICANTS

SHELL TELLUS OIL

SHELL

Here's a crystal ball

that accurately predicts metal performance at high temperatures:

Inco's in-plant test rack program

Do you know that Inco sets up a test rack containing a large selection of alloys in critical hot spots in many types of operations:—one rack or more . . . whatever it takes to find out which alloy stands up best under a host of varying high temperature conditions.

What's more, Inco's High Temperature Engineering Service tabulates the data . . . analyzes it in a report like the one above: complete . . . accurate . . . unbiased.

Perhaps the answer to your high temperature problem has already been found . . . if not, we will be glad to arrange for a rack test. All you have to do to get the crystal ball rolling is to fill out the coupon below. Do it now.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.

GENERAL ELECTRIC ANNOUNCES . . .

NEW Industrial

Direct-current Motor

KINAMATIC* a new standard in direct-current motors, gives your machines wider speed ranges, greater output

To meet modern industrial needs for faster, more automatic, more continuous production, General Electric has designed an entirely new direct-current motor—the d-c Kinamatic.

Designed for Automation—Now, a direct-current motor has been designed for the modern job it has to do—either as individual motor drive or in regulating systems. The new General Electric d-c Kinamatic motor supplies the wide speed range and versatility required for today's manufacturing methods. It is designed for the close control of machines and split-second timing of processes essential to higher output.

Accelerated Production—The new d-c Kinamatic motor will modernize your equipment, give it increased power, higher speeds, greater output capacity. With the quick-acting G-E Kinamatic motor, your machines will process a greater variety of products . . . faster . . . easier . . . and with less maintenance and spoilage.

More Powerful—By combining advanced design with improved materials and manufacturing techniques, General Electric engineers have packed more power into the entire Kinamatic line. The powerful Kinamatic motor, with new stamina and durability, is ready to become one of your most effective weapons for keeping costs down, for meeting competition, for boosting productivity levels.

Engineering Help—Industrial specialists in 149 conveniently located General Electric Apparatus Sales Offices have the complete story on how the new d-c Kinamatic motors and generators can benefit your operation. For full details, contact your G-E Sales Representative, or write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 813-1

* Trade Mark of the General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC

When you design-in seals

Think of Oil Seals This Way

a. b. c. d.

a. Outer Case

Formed to extreme close tolerance of heavy gauge steel with sufficient structural strength to maintain precision dimension.

b. Sealing Lip

Properly prescribed material either compounded or processed for application conditions of temperature and eccentricities. Precisely molded for correct shaft interference, low torque and positive sealing.

c. Tension Spring

Carefully engineered as to metallurgy, heat treatment and coil diameter to provide uniform compressive force on the sealing element.

d. Inner Case

Strengthens, protects; sturdy gauge steel formed to close tolerances.

4227

A good oil seal is a carefully engineered, precision manufactured assembly of carefully engineered, precision manufactured components. Each part must be exactly right *for the given application* or the seal will not function properly.

You avoid dangers of costly retooling, remanufacture or premature replacement when seals are correctly specified during your product's design stage. Each sealing application is different; many designers use National's field engineering service to be sure correct—and latest—oil seals are used.

Why "do it yourself?" Call the National Seal field engineer now. His service involves no obligation.

NATIONAL SEAL
DIVISION, Federal-Mogul-Bower Bearings, Inc.
GENERAL OFFICES: Redwood City, California
PLANTS: Van Wert, Ohio, Redwood City and Downey, California

36th year

CHICAGO, ILL. . . *Room 462, McCormick Building, HArrison 7-5163*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DETROIT, MICH. . . . . *13836 Puritan Avenue, VErmont 6-1909*
DOWNEY (Los Angeles County), CALIF. . . *11634 Patton Road, TOpaz 2-8163*
INDIANAPOLIS, INDIANA . *2802 North Delaware Street, WAlnut 3-1535*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . . . . *1180 Raymond Blvd., MItchell 2-7586*

Design data on adhesives

Armstrong
ADHESIVES • COATINGS • SEALERS
USED WHEREVER PERFORMANCE COUNTS

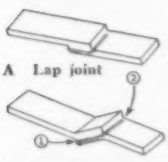
NUMBER ONE

How to design joints for adhesives

Many common joints can be re-designed to give maximum strength with adhesives. The examples shown do not cover every situation, but they do illustrate how four basic design rules can be applied to improve strength. These rules are:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which the adhesive is weakest.

Strengthening a lap joint:



Under stress, a common lap joint such as "A" tends to deflect as the assembly aligns itself. Instead of a simple shear stress, the joint in effect more nearly resembles drawing "B". The tension effect at edges "1" and "2" tends to peel the bond apart, since a high proportion of the load is carried at the edges of the lap.

Greater proportion of bonded area now contributes to strength. (Rule 2) Stress is now reduced in the direction in which the adhesive is weakest. (Rule 4)

Even greater proportion of bonded area now contributes to strength, (Rule 2) Stress is further minimized in the direction in which the adhesive is weakest. (Rule 4)

Maximum proportion of bonded area now contributes to strength. (Rule 2) Adhesive is now stressed in the direction of its maximum strength. (Rule 3) Stress is now minimized in the direction the adhesive is weakest. (Rule 4)

Production line application of adhesives

It is as important to choose the right method of applying the adhesive as it is to select the proper adhesive.

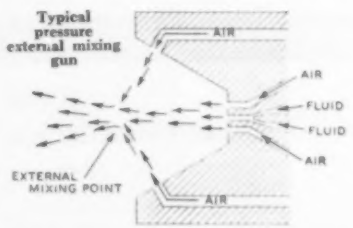
A straight-line manufacturing process with parts handled by a mechanical conveyor obviously is the most desirable setup. The adhesive is applied at the first stage, the adhesive film prepared for bonding in the second stage, and the application of pressure, if necessary, in the third stage.

The methods of application most suitable to straight-line production are spraying and roller coating.

1. Spray coating

Spray coating offers the same advantages for adhesives as for paints. Adhesives ranging from water-thin resins to viscous synthetic rubber products and even abrasive-filled materials are applied in this manner.

Some adhesives and coatings may be applied as an even, perfectly smooth film. Materials of this type should be sprayed with a pressure type (not suction) external mixing gun. The intermediate nozzle or fluid opening sizes ordinarily used for paints will control the amount of fluid ejected into the air stream, so that all of the fluid is "atomized." Fast-drying adhesives, particularly those based on synthetic rubber, cannot be applied with



paint smoothness, but will spray with uniformity in almost any thickness desired. Selection of the correct air gap and fluid opening is important. Large fluid openings are better with viscous adhesives, but only if air pressure can be increased proportionately. With synthetic rubber type adhesives, higher air pressure is usually needed for breakup of the fluid stream.

Adhesives of this type can be improved by lowering the viscosity by dilution, using the recommended solvent. In using an adhesive that has been severely thinned, it must be remembered that solids content is low.

In many applications, the speed and economy offered by automatic spray equipment will quickly repay the investment required. Where the nature of the work requires hand spraying, some of the more important points are: hold the gun no more than 7″ or 8″ from the work; "trigger" the gun at the end of each pass rather than attempt to operate the gun continuously; hold the gun at right angles to the work to insure uniform film thickness.

2. Roller coating

Where continuous production runs of sheets of one thickness are involved, roller coating is fast and economical.

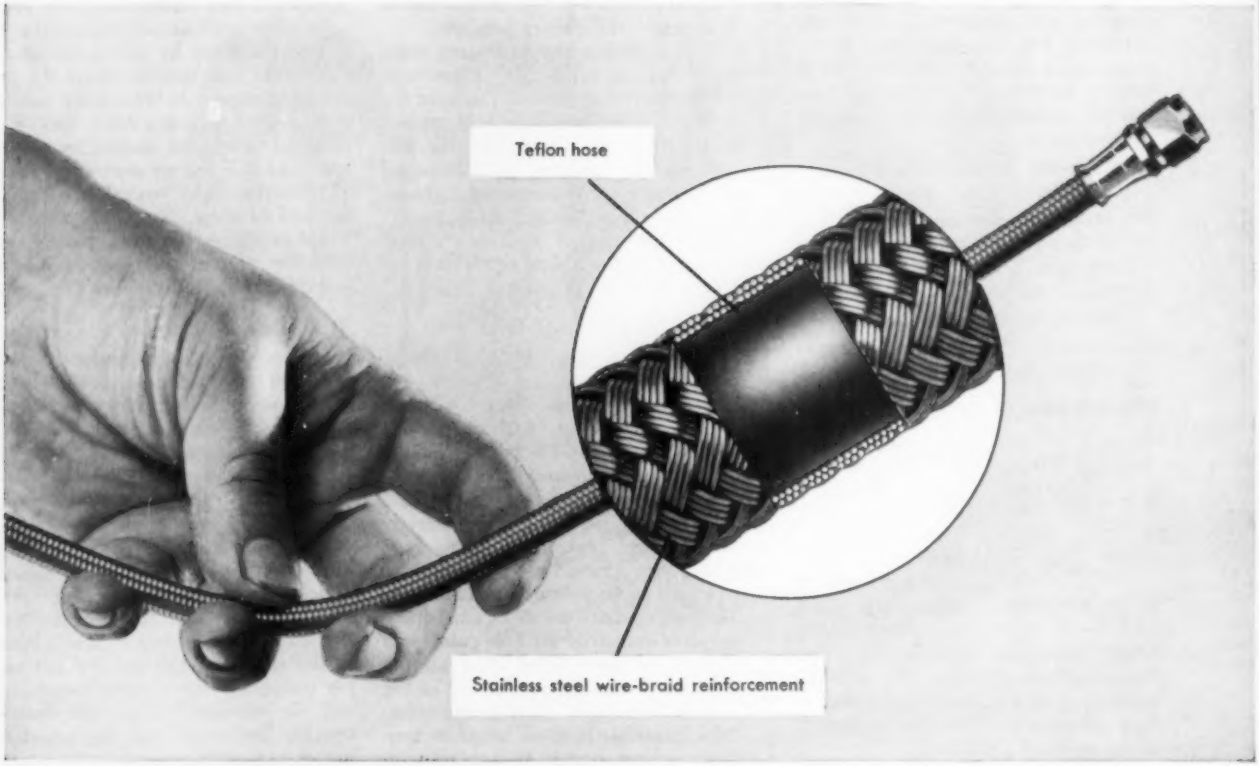
If properly compounded, most water base adhesives will roller coat on standard equipment.

Fast-drying adhesives of the synthetic rubber type require slight machine modification and a different technique. Most solvents for adhesives will attack rubber or plastics so that metal rolls must be used throughout. Synthetic rubber adhesives tend to adhere to the applicator roll and will not apply uniformly from a smooth-surfaced roll. To remedy this, the roll should contain "reservoirs" for the adhesive and enough surface irregularity to prevent suction. This may take the form of grooves at right angles to the roll axis or small cups engraved on the roll. In either case, the area between the grooves or the cups should be cross-hatched or broken up in some way. The amount of adhesive applied is determined by the depth of the machined "reservoirs" and their spacing.

While the coater is in use, the adhesive should be prevented from losing solvent by evaporation, which increases viscosity. To do this, the adhesive should be fed to the pan continuously at the used rate. The pan should be covered or the adhesive stirred in the pan for uniform feed to the take-up roll. Production should be as nearly continuous as possible.

For more information on adhesives—and design problems involving adhesives—write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, Industrial Div., 8005 Irvin Street, Lancaster, Pa.

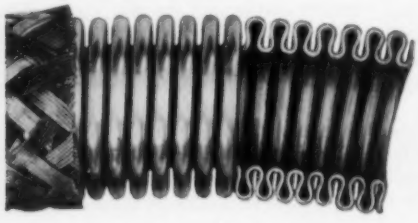
NOW! A Tough Material To
Introducing AMERICAN FLEXIBLE



NAME YOUR PROBLEM. American has the flexible connector to meet it.

AMERICAN SEAMLESS

Easily installed, low-maintenance, long-life tubing of bronze, carbon steel, stainless steel, Monel, cupro nickel, brass and other workable metals solve most flexible connector problems involving steam, oil, liquids, gases, etc., under pressure; for absorbing vibration in rigid pipelines, connecting misaligned ports; for piping in limited space and service where there is intermittent or continuous flexing.



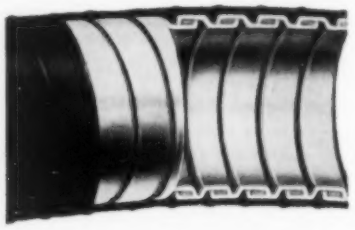
AMERICAN STRIPWOUND

Combines all-metal strength with extreme flexibility, permitting easy installation and handling. Made in bronze for conveying steam and water, in steel for conveying oil, tar, asphalt, etc., and in copper, aluminum, carbon steel, stainless steel, and other metals for special applications. With or without wire braiding.

AMERICAN SEALTITE†

Flexible, liquid-tight conduit. Protective raceway for electrical wiring, made of a flexible galvanized steel core with tough extruded plastic jacket. Completely liquid-tight, resists chemicals. Absorbs movement, vibration, simplifies installation in tight spaces or where there is offset.

†Trademark



Meet Tough New PROBLEMS
TEFLON HOSE

Heat-resistant, corrosion-proof, lightweight Teflon* flexible hose absorbs vibration, takes up movement, simplifies offset connections and installations in cramped spaces

FOR AIRCRAFT, GUIDED MISSILES AND ATOMIC ENERGY FIELDS. American Flexible Teflon Hose offers the double advantage of economy and longer life in many applications: fuel lines, oil lines, oxygen lines, hydraulic lines and others.

Properties include complete tightness under high pressures, high resistance to fatigue, torsion and corrosion, light weight and capability of continuous service in temperatue range of—100°F. to 500°F. Unaffected by any known type of fuel, oil, or acid within the temperature range of the hose.

FOR TOUGH INDUSTRIAL JOBS. American Flexible Teflon Hose promises long, economical service in many industrial applications. It is ideal where lines are subjected to outdoor exposure or attack by chemicals, or where high temperatures are a factor—either in the material being conveyed or plant surroundings.

HOW CAN YOU USE AMERICAN FLEXIBLE TEFLON HOSE TO REDUCE COSTS OR IMPROVE PRODUCT SERVICE? American Metal Hose engineers will be glad to consult with your engineers. Write for bulletin TF-100, or call: The American Brass Company, American Metal Hose Division, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

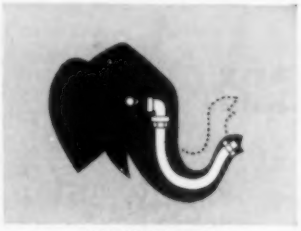
*DuPont trademark for its tetrafluoroethylene resin

Contact American to solve problems of . . .

VIBRATION

OFFSET CONNECTIONS

CRAMPED SPACES



MOVEMENT

WHEREVER CONNECTORS MUST MOVE

AMERICAN

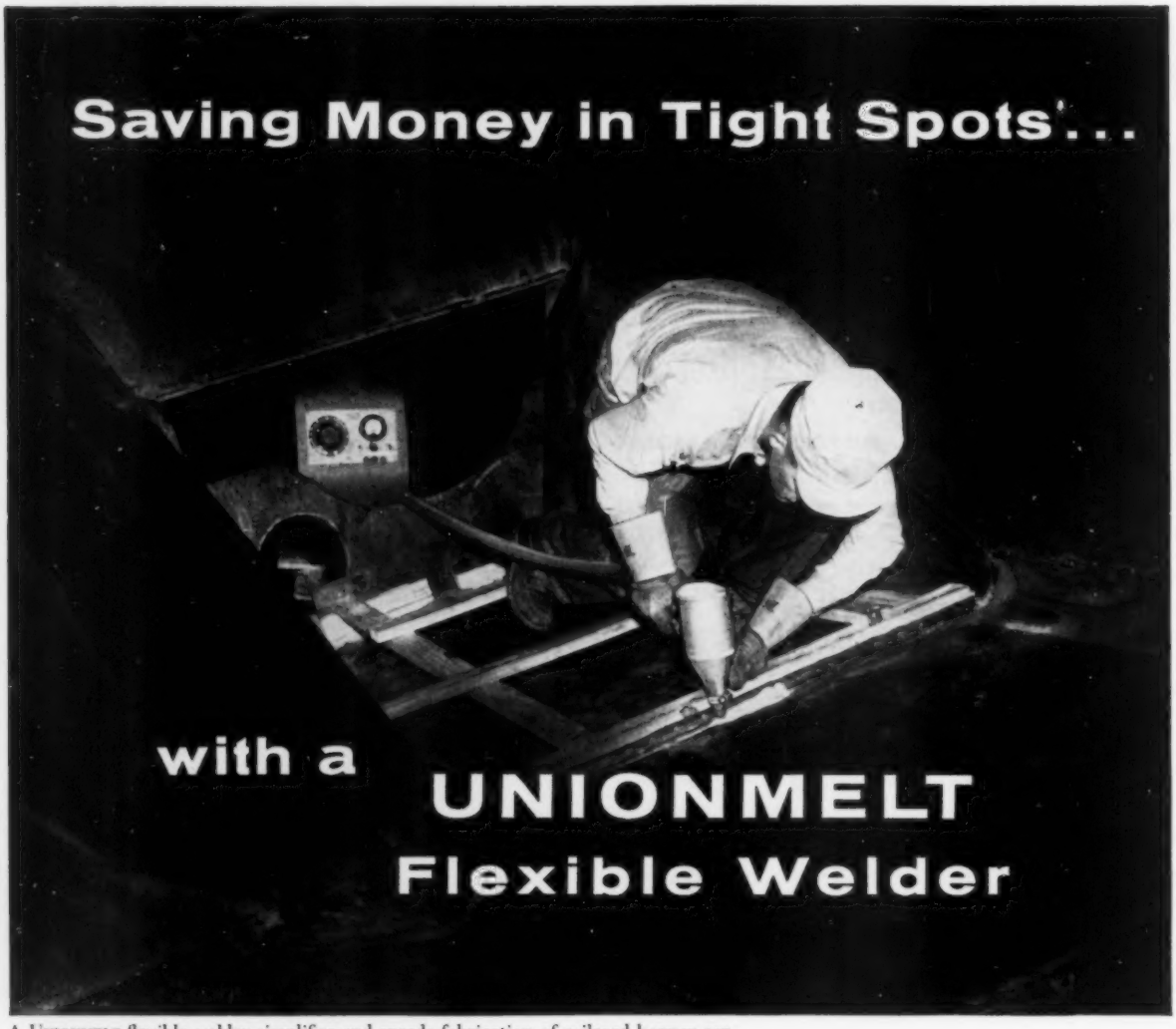
FLEXIBLE METAL AND TEFLON HOSE AND TUBING

AN

ANACONDA®

PRODUCT

Saving Money in Tight Spots...



with a **UNIONMELT**
Flexible Welder

A UNIONMELT flexible welder simplifies and speeds fabrication of railroad hopper car.

Wherever flexibility and maneuverability are required in welding, the UNIONMELT flexible welder far outperforms rigid, mechanical installations . . . Welding in corners and in tight spots is no problem with this sturdy portable unit, and top quality welds are produced at speeds up to 40 inches per minute in many operations. The combination hopper and welding head is lightweight, and requires no special skill to operate.

Combines Advantages

This UNIONMELT flexible welder combines the speed of mechanized installations with the operational freedom of manual welding. Wire feed unit and controls are mounted on a mobile carriage which can be moved quickly from one job to another, or from point to point on the same job. Initial investment for flexible welding equipment is considerably less than for stationary automatic welding installations—operations are economical, and maintenance costs are low.

For more information on this and other modern methods for joining metals, call your local LINDE representative, or write for free illustrated literature.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto

The terms "Linde" and "Unionmelt" are registered trade-marks of Union Carbide.

Linde Trade-Mark

VERSATILE

Double A VALVES SPECIFIED

"to simplify hydraulic circuits . . . reduce costs"

This 450 ton compression press made by Baker Brothers Inc., Toledo, is the first ever built with provision for complete automation in the production of phenolic plastic parts. A battery of four — equipped with Double A Valves — currently turns out all the pump impellers for one of the "big three" automobile manufacturers.

Typical of valves on Baker Presses is this 1½" solenoid-controlled, pilot-operated, 4-way valve. It is pressure-centered — for faster shifting, and it's completely dependable — no spring failures!

Here's why Baker Brothers specified Double A Valves: You can modify one of Double A's many standard valves and come up with a valve that will replace two or, in the Baker presses, for example, four ordinary valves.

As a Baker Hydraulics Engineer put it, "Double A Valves are so versatile we were able to simplify our hydraulic circuits with a consequent saving in cost and space."

Double A's complete line of valves — the ease with which they lend themselves to modification — and the willingness of Double A engineers to work with you on modifications for specific jobs, can mean actual dollar savings to you.

For the full story on All Double A Valves, write for Catalog No. 551.

●

REPRESENTATIVES IN PRINCIPAL CITIES IN THE U.S. AND CANADA

●

Double A

PRODUCTS CO.

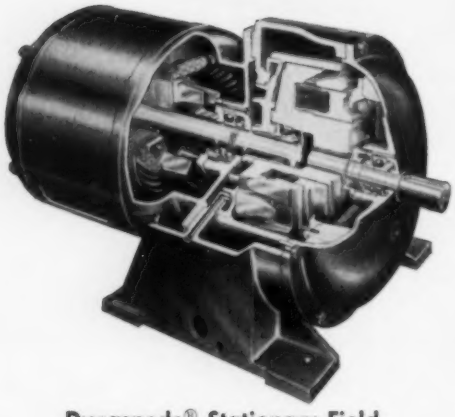
Manchester, Michigan

No Commutators, No Rings, No Brushes, No Rotating Coils—in the NEW

EATON

DYNAMATIC®

Adjustable Speed Drives



Dynaspede® Stationary Field Coupling, with Integral Motor

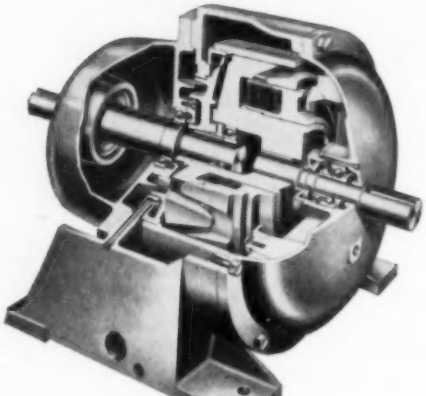
Dynamatic stationary field couplings are the simplest drives so far devised to provide infinitely adjustable speed from an alternating current source. The absence of rotating coils, brushes, slip rings, and commutators in this design holds wear and maintenance to an absolute minimum. Dynamatic electronic or magnetic amplifier controls, in combination with these drives, provide wide latitude in operating functions.

Check these Outstanding Advantages:

Accurate speed control • Wide speed range • Low power losses • Simple construction • Rapid response • Remote control • Quiet, efficient operation • Low maintenance costs

Ajusto-Spede® Drives: Air cooled, stationary field eddy-current couplings mounted integrally with D-flange open drip proof squirrel cage motors are available in capacities from 1 to 75 HP. Units of the same design and capacities are also available without motors.

Dynaspede® Drives: Liquid cooled, stationary field couplings mounted integrally with D-flange squirrel cage motors are available in capacities from 3 to 75 HP. Motor types available are drip proof, splash proof, totally enclosed fan cooled, and explosion proof. The coupling is totally enclosed. Separately mounted couplings are also available in capacities from 3 to 2500 HP and larger.



Stationary Field Coupling for use with Separately Mounted Motor

Send for Detailed Information on these New Stationary Field Couplings and Drives

EATON MANUFACTURING COMPANY
DYNAMATIC DIVISION
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

WAITING FOR A CHANGE

Development of aircraft and aero engine design is a pattern of never ending changes and modifications. Improving engines and airframes demands more strength in more and better parts. Example: There are about 1,300 machined parts in the F-100A. In the F-100D, improvements have added 500 more. Higher power and speeds in the same size airframe call for improved elevated temperature performance in alloys for structures, forgings and fasteners.

The big problems have been the forgeability and machinability of the tough alloys used in the intermediate elevated temperature applications. But they're being licked. Carpenter is now producing uniform elevated temperature alloys of very high quality which consistently meet tough aircraft specifications. Their quality and cleanness also allow tightened forging tolerances, improve machinability and cold forming properties. Result: More accurate forgings with better finishes . . . fewer rejects . . . faster production.

Complete information on application, fabrication and engineering properties of these alloys is summarized in our new booklet, "Carpenter Alloys for Elevated Temperature Service". For your copy, drop us a line on your Company letterhead. The Carpenter Steel Company, 117 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service

US RUBBER

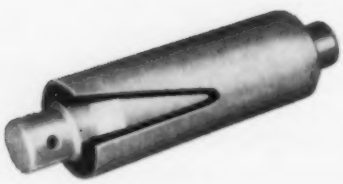
Engineered Rubber Products

Mass-produced to exacting specifications

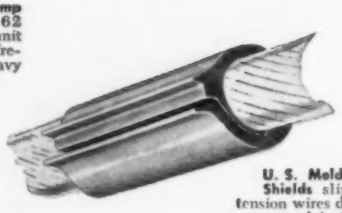
U.S. MOLDED TRAIN DIAPHRAGM (left) for new "Talgo" and other lightweight trains provides neater, stronger, more flexible covering for joints and couplings. That's why it was selected for these revolutionary trains. To keep up with the modern "look" and performance of this new railroading design, this "U.S." bellows-type diaphragm flattens out or compresses as the train takes curves at speeds never before attained. To do this and still retain its shape and strength, the diaphragm was carefully engineered of cloth-inserted, fire-resistant neoprene rubber, produced to the exact specifications of the customer.

This is only one of hundreds of applications where U.S. Engineered Rubber Products do jobs no other material can do, *especially in mass production*. There are factory trained engineers ready to help you solve any molded rubber problem. Contact us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

Visit our Booth #822, Design Engineering Show, New York Coliseum, May 20-23



U. S. Molded Oil Pump Bearings eliminate 62 conventional pumping unit parts, and absorb high-frequency vibrations and heavy well shocks.



U. S. Molded Line Hose Shields slip over high-tension wires during maintenance and installation. Very flexible, sturdy, resists up to 30,000 volts.

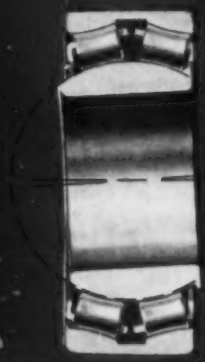
U. S. Molded Diaphragms for motor valves regulating the flow of liquid through piping systems. Precise, uniform molding makes them standard equipment of leading motor valve manufacturers.

US RUBBER

Mechanical Goods Division

United States Rubber

self-aligning . . . CAN'T BIND



HOW SELF-ALIGNMENT WORKS. Spherical inner ring, free to align in any direction, assures full load capacity regardless of shaft deflection or support misalignment.

Husky bearings in husky housings adjust immediately in any direction

When high-impact loads deal out punishment, shaft deflection may spell a quick finish for ordinary bearings. But this rugged Link-Belt bearing is *self*-aligning . . . won't "pinch" or bind when misaligned.

Complete protection is provided by effective seals which block entrance of dirt, escape of lubricant. Durable housing—machined as two perfectly matched parts provides easy installation without shims or alignment rings.

Get full data on Link-Belt's complete bearing line from Book 2550. Ask any of 40 offices.

Series 6800, 6900, 7800, 7900 roller bearings have internationally standardized boundary dimensions.

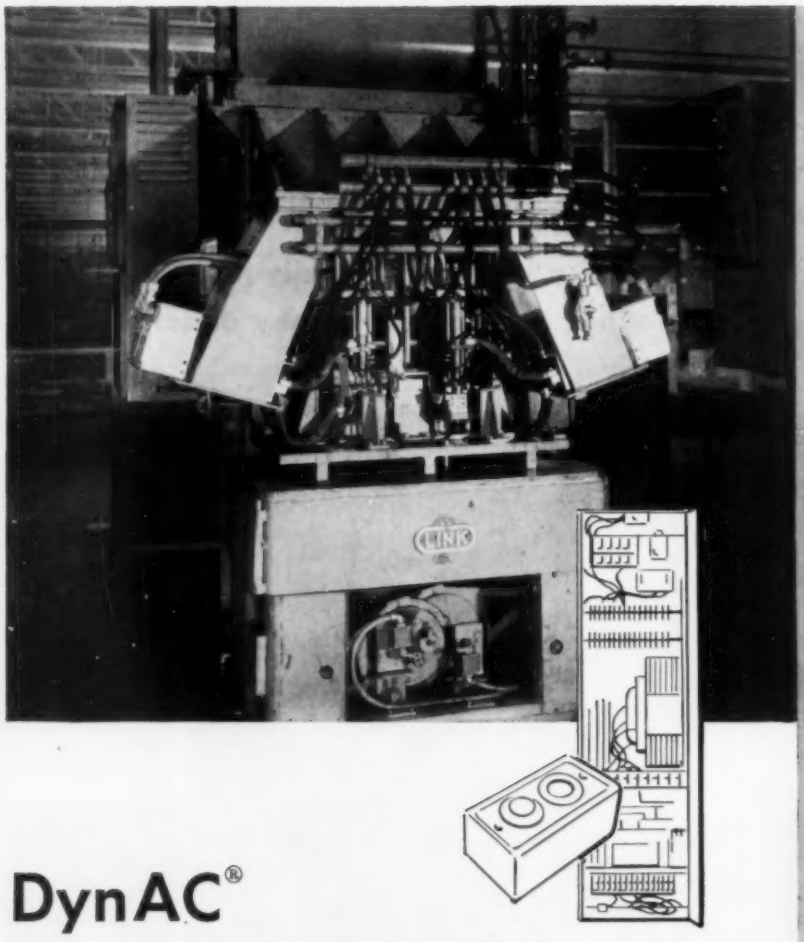
LINK BELT

self-aligning ball and roller bearings

14,441-A

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

Visit our exhibit, Design Engineering Show, New York Coliseum, May 20-23



DynAC®
stops welding table over 28,000 times per day!

Six hundred complete welding operations per hour, twenty-four hours a day, without the costly maintenance and wear of mechanical braking. That's the kind of record-breaking performance made possible with Westinghouse DYNAC.

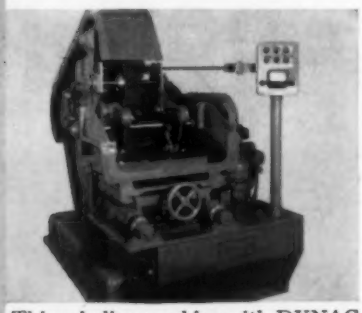
DYNAC on this automatic welder provides braking action for the welding table, stops it in exact position for welding or loading. Each operation requires the motor to start and stop twice . . . twenty stops per minute—28,000 per day!

DYNAC provides smoother, faster stops . . . boosts production. Completely electrical, DYNAC can be installed simply and quickly, anywhere—at machine or for remote operation.

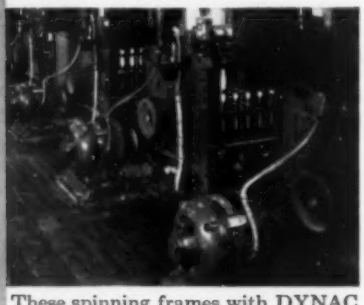
For the complete DYNAC story, call your local Westinghouse distributor or office . . . or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-22035

YOU CAN BE SURE...IF IT'S Westinghouse

HERE ARE SOME TYPICAL DynAC APPLICATIONS:

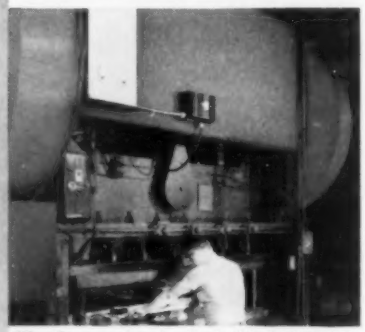


This grinding machine with DYNAC produces more finished pieces because of a faster work cycle.



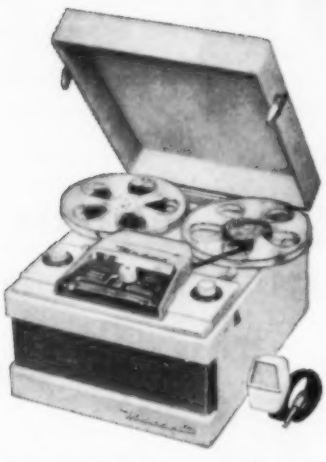
These spinning frames with DYNAC have saved textile producers over $3,000 per year per 100 frames.

These conveyors using DYNAC can be stopped once a minute, day in and day out, without any maintenance.

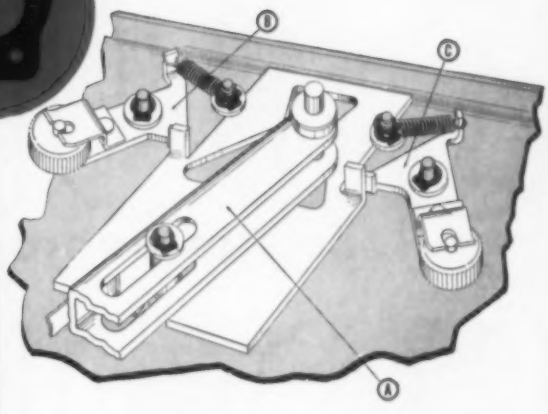


The heavy flywheel of this DYNAC-equipped stamping press can be stopped in just 24 seconds . . . former stopping time was a full eight minutes.

Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining



Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5555 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.
The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

WALDES
TRUARC®
RETAINING RINGS
WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name _____
Title _____
Company _____
Business Address _____
City _____ *Zone* _____ *State* _____

PN 059

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

See the Truarc Exhibit at the Design Engineering Show, New York Coliseum, May 20th to May 23rd. Booth No. 1010.

STOP

BOOTH 705

... AT THE DESIGN ENGINEERING SHOW

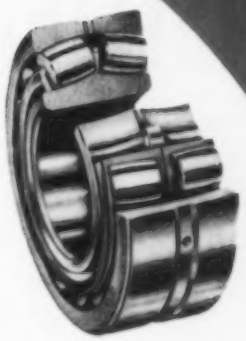
LOOK

... AT THE NEW LINE OF SKF BEARINGS

LEARN

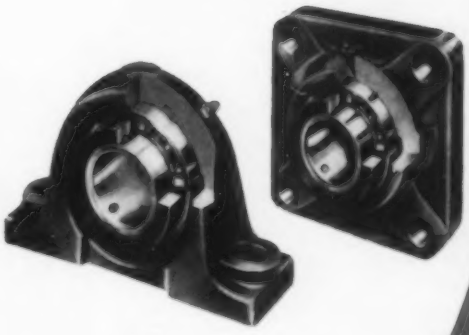
... HOW SKF CAN HELP YOU

When you visit the Design Engineering Show at the New York Coliseum, May 20 to 23, SKF will show the world's finest, most extensive and versatile assortment of anti-friction bearings. Here are just a few of the high spots of interest:



■ The newly-improved Type "C" spherical roller bearing which gets lubrication where needed—at the center... gives increased capacity and life.

■ New cast steel housings for heavy-duty service where cast iron housings will not meet rugged requirements.



■ Complete line of unit pillow blocks and flanged housings with external dirt flingers and internal Fairprene seals that retain lubricant.

■ Famous SKF ball bearing line available with any of 18 combinations of seals, shields and snap rings.

■ Ty Seal Tapered Roller Bearing, that is easy to install and keep clean... prelubricated... Neoprene sealed. 7760

Stop in and let us show you the right bearing for your needs. Or, call your SKF distributor or SKF Sales Engineer.

SKF

EVERY TYPE—EVERY USE

- *Ball Bearings*
- *Cylindrical Roller Bearings*
- *Spherical Roller Bearings*
- *Tapered Roller Bearings ("Tyson")*

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

DESIGNER'S FAVORITE SENSITIVE, VERY RESPONSIVE

Thermoswitch® Is Rugged, Adaptable, Heat Controller

ASHLAND, MASS. — Word emanating from here is that Fenwal Incorporated's THERMOSWITCH units are usually the best solution for a design engineer with temperature-control problems.

THERMOSWITCH thermal controls are adaptable, sensitive, responsive, small, tough, and accurate — and their price is right. They frequently replace controllers costing much more, and do a better job.

Their principle of operation is unique — and highly competitive in terms of every quality most design engineers would require. The unique principle is this: *the activating control element is a single-metal shell that expands or contracts instantaneously with temperature changes, making or breaking the totally-enclosed electrical contacts.*

Design engineers have put THERMOSWITCH units to work everywhere that temperature control is vital — in planes . . . factories . . . ships . . . hospitals . . . food-processing plants . . . homes . . . laboratories. The list of THERMOSWITCH applications is virtually endless. So is the list of physical ordeals the units have survived and the high performance standards they've met.

When tested alongside bulb-type and enclosed bi-metallic thermostats under identical conditions, THERMOSWITCH units have overwhelmed both with performances like these:

- reaction speed, four to nine times as fast;
- heat-responsive area, three to six times as large;
- heat-transfer path, only one-third to one-sixth as long;
- temperature differential, only one-tenth to one-nineteenth as great;
- vibration-sensitivity, only one-twelfth to one-eighteenth as great;
- shock-sensitivity, only one-tenth to one-eighteenth as great;

FENWAL THERMOSWITCH UNITS may solve your temperature control problems, too. Sensitive, tough, and accurate — they have been put to work by designers wherever temperature control is vital. Over 25,000 variations of the THERMOSWITCH unit are available. Write for THERMOSWITCH folder.

Added to these points of superiority are such demonstrable features as uniformity of sensitivity throughout the operating range, built-in temperature anticipation, enclosed tamper-proof assembly, direct radiant heat reception, and an operating range from −100°F. to 600°F.

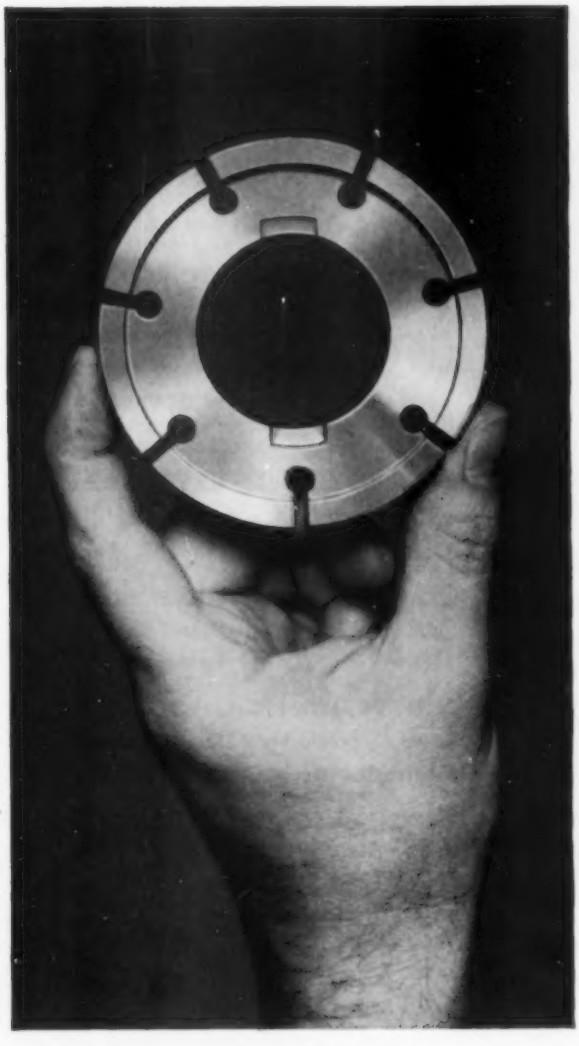
Other ranges are available, too. The point at which a unit makes or breaks a circuit is determined by a set screw easily adjusted in the field.

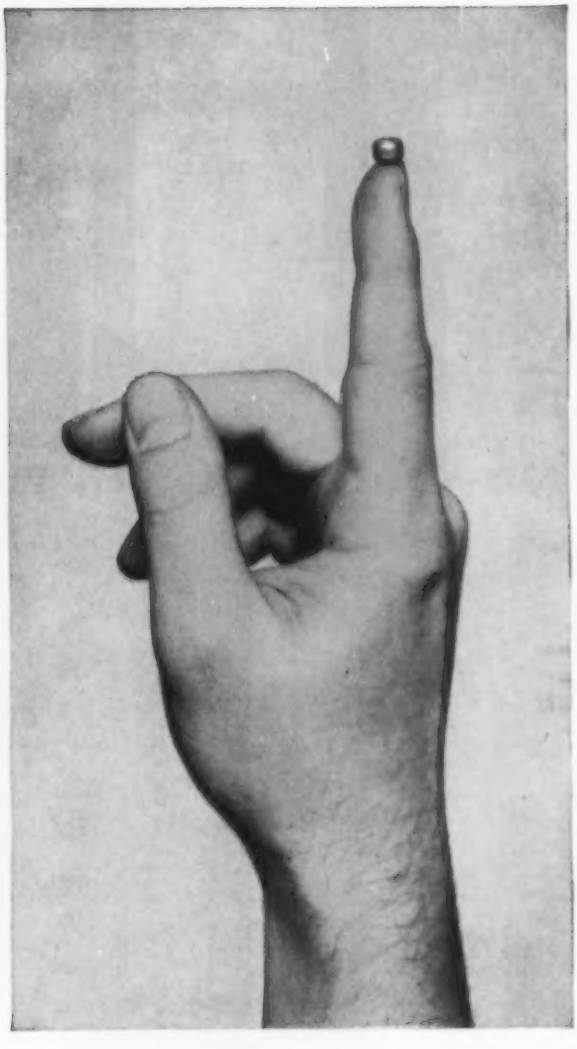
There's a Fenwal sales engineer ready to help you apply THERMOSWITCH units to your particular heat control problems — ready with over 25,000 variations. Write Fenwal for his name and for complete specifications. **Fenwal Incorporated, 26 Pleasant Street, Ashland, Mass.**

Fenwal

CONTROLS TEMPERATURE ... *PRECISELY*

See us at Design Engineering Show, Booth 1414, New York Coliseum





Does *weight* limit use of metal powder?

One of these metal powder parts is light, the other heavy. And while each varies widely in appearance and characteristics, *both* were easily produced by Moraine Products from metal powder.

Unit costs are less because each part could be mass-produced in a single press operation. Yet, the closer-than-ever tolerances that resulted in improved on-the-job performance were maintained.

Moraine Products has the experience gained from the production of hundreds of millions of metal powder parts in an infinite variety of shapes and sizes. Countless application problems have been solved through our experience in powder metallurgy. And, because we recognize the limitations as well as the advantages of metal powder, each specific assignment is studied and judged individually.

When we accept a job to make metal powder parts, it is only after thorough study has shown that the customer will receive parts of the highest uniform quality for dependable end-product performance. Of course, on-time delivery is assured, regardless of quantity.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials —Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio

INSIDE INFO FROM HOLO-KROME

THE SECRET'S IN THE SOCKET!

Holo-Krome's forging method assures untapered sockets . . . lets the hex key bear evenly and firmly against the entire socket wall. The result: easier, faster assembly . . . longer key life . . . fewer damaged screws!

No wall taper in Holo-Krome sockets!

Compare These Other H-K Features!

COMPLETELY FORGED SOCKET HEAD . . . no drilling or broaching—metal fibers stay intact for stronger hex sockets.

SCIENTIFICALLY DESIGNED SOCKETS . . . depth carefully proportioned to give greatest head and socket strength, firmest key grip.

SHARP HEX CORNERS . . . carefully formed socket corners resist internal reaming.

For the finest in Socket Screw products . . . for revolutionary SAME-DAY SERVICE, the name to remember is Holo-Krome!

LOOK INSIDE A HOLO-KROME SOCKET!

Send in the coupon below and we'll send you FREE an H-K Socket Cap Screw (we've omitted heat treating to let you get a better look at the mirror finish and sharp hex corners under the usual black finish). Look it over carefully, and see for yourself what a real difference H-K quality and skill can make!

Please send me FREE a Holo-Krome Socket Screw for my inspection.

NAME _____

POSITION _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

HOLO-KROME

THE HOLO-KROME SCREW CORP., HARTFORD 10, CONN.

Sold only through authorized Holo-Krome distributors.

Potter & Brumfield *engineering is in this picture*

The rig is down. A part is needed fast! A call to the warehouse on a mobile 2-way radio gets action, saves money, keeps production flowing.

Which P&B relay would you specify to keep conversation going over a MOBILE 2-WAY RADIO?

MB Series

TS Series

MC Series

When one of America's leading manufacturers of electrical and electronic equipment began the design of a lightweight 2-way car radio, they were faced with several specific requirements in selection of relays. They had to be compact, light in weight and engineered to withstand the shock and vibration of off-the-road service. P&B engineering solved the problem with a modification of the TS series multiple switching relay.

In this application the TS relay has a dual personality. It connects the power supply unit to *both* the transmitter and the receiver. Power supply is controlled through the relay to either unit by the operator.

This is just another example of how P&B engineering is daily adapting standard types of relays or designing completely new types to meet specific requirements of new products. P&B's unique 25 years of engineering experience in relay applications is a source of quick, correct answers to your relay problems. Write today for new compact catalog.

ENGINEERING DATA

SERIES: TS. Miniature off-set springs telephone type.

CONTACTS: 5/64" dia. palladium (rated 3 amps.) ½" dia. pure silver (rated 5 amps.).

CONTACT ARRANGEMENTS: Up to 20 springs, maximum 10 in each stack, using any form combinations within max. limits.

VOLTAGE RANGE: DC: up to 220 V. AC: up to 230 V. (4 poles).

COIL RESISTANCE: 30,000 ohms. Shaded coil available for 60 cycle operation up to 230 V. using 4.7 VA nominal.

POWER REQUIRED: 100 mw. per movable arm.

TEMPERATURE RANGE: Stack insulation of XXX phenolic spacers: —55° C. to +85° C. Glass melamine spacers: —55° C. to +125° C.

TERMINALS: Pierced solder lug holes for 2 No. 16 hook-up wires. Also available: Push-on taper tab connectors.

ENCLOSURES: Dust cover or hermetically sealed enclosures: Round: With octal plug (Max. of 8 springs) Rectangular: With octal plug, 4 to 14 pierced solder lugs, header to fit 14-pin miniature relay socket. Multiple solder header 18 springs Max.

DIMENSIONS: (4 Form C) 1-19/32" L. x 1-1/16" W. x 1⅝" H. (open) (4 Form C) 1⅝" L. x 1-13/32" W. x 2-3/16" H. (Hermetically sealed) (6 Form C) 1-29/32" L. x 1-5/16" W. x 2-9/16" H. (Hermetically sealed).

The standard TS structure with a life of 100 million operations will soon be available.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

Potter & Brumfield, inc. PRINCETON, INDIANA

See our catalog in Sweet's Product Design File.

Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

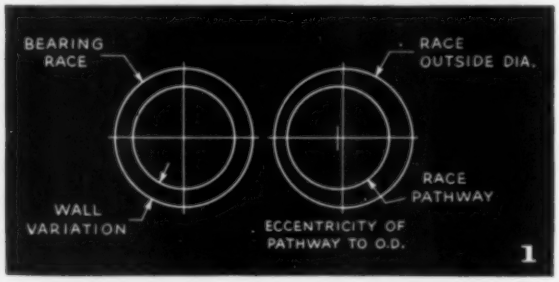
The Inside Secrets of Smoother Performance

How HYATT quality controls assure race concentricity, roller diameter uniformity and other internal essentials of smoother, longer-lived cylindrical roller bearings . . .

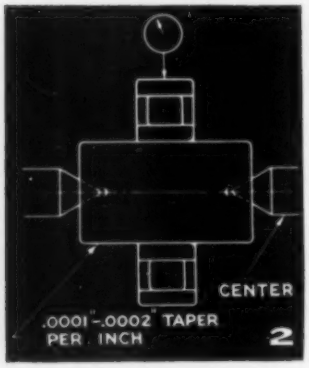
The running accuracy and smoothness of a roller bearing is governed primarily by its internal dimensions and clearances. The most important of these are:

1. CONCENTRICITY OF RACE DIAMETERS

Eccentricity of race diameters is usually interpreted in terms of *wall variation*, Figure 1, on the individual components and in terms of *radial run-out* on the assembled bearing. The



assembled bearing is usually mounted on an arbor, Figure 2, having a slight taper (.0001″ to .0002″ on the diameter per inch of length) and the radial run-out indicated as shown. The radial run-out is the difference between the minimum and maximum readings obtained when rotating the outer race one revolution with the arbor stationary for outer race radial run-out, or rotating the arbor one revolution with the outer race stationary for inner race radial run-out.

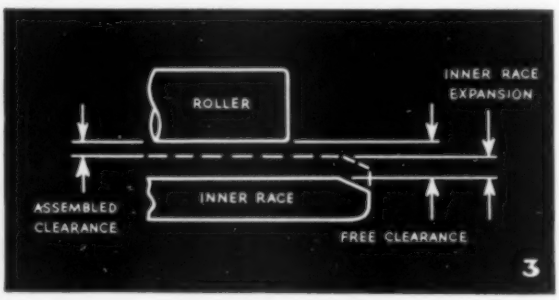


2. UNIFORMITY OF ROLLER DIAMETERS

Another factor governing running smoothness is *roller diameter uniformity*. This is usually obtained by segregating the rollers into diameter variation classes of .00005″, .0001″, or .00015″, depending on the bearing size and the nature of the application, and assembling only rollers of the same group into a given bearing. Gauging for this segregation necessarily rejects excessive taper.

Uniformity of roller diameters is important for another purpose. It provides the user with a bearing in which the internal diametral clearance is controlled within the closest possible limits. The rollers are matched with races which are segregated for pathway size in a fashion similar to the rollers, usually to twice the diameter limits of the rollers. The internal clearance can thus be manipulated at will by combining various diameter classes of races and rollers; but once a particular range is selected, it will remain constant within the combined limits of the roller and race pathway diameter limits. Here, again, a tapered condition of the race pathway is automatically rejected.

Obviously, the internal clearances of commercial bearings must be standardized for the practical reasons of cost and availability, but the clearance values have been so selected that under the specified fits the *running* clearance is at the most desirable minimum, depending on bearing type and size. Figure 3 (magnified).

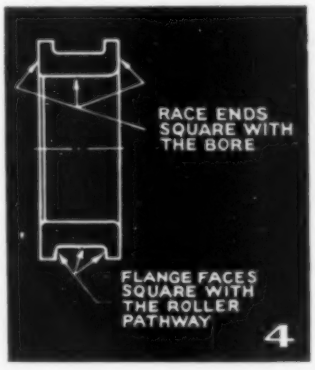


Checking wall variation, flange run-out and race end squareness on combination gauge.

3. SQUARENESS OF ROLLER ENDS AND FLANGE FACES

One other tolerance that contributes to the running efficiency of HYATT Hy-Load Series Bearings of the flanged race type is the *squareness of roller ends with roller diameters* and the *squareness of flange faces with the race pathways.*

Flanged race bearings are commonly used for locating shafts laterally and for running conditions of light and intermittent thrust load. For best operating results, the ends of the rollers must be flat and square with the diameter within a matter of tenths. The lateral clearance between the roller and the race shoulders must also be held to a minimum. This means close tolerances on roller length and race pathway width, and the flange face, Figure 4, must be square with the roller pathway. When all these conditions are satisfied, there will be no tendency for the rollers to skew and raise the operating temperature of the bearing, nor will there be any unusual force on the separator or cage with a tendency toward wracking and noisy operation.



The *side run-out* of the individual races or the *out-of-square* of the ends with the fitting diameters is also important, especially in applications where a number of parts are held together endwise and where the pressure might be sufficient to tilt the race, creating a condition of excessive taper on the roller pathway with consequent roller skewing and the development of excessive heat and noise.

All these internal dimensions and clearances are so carefully controlled that HYATT Hy-Roll Bearings have built an unsurpassed reputation among design engineers for exceptionally long, smooth and trouble-free performance.

YOU WILL FIND MORE DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your design requirements. Remember, HYATT is America's first and foremost maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT *HY-ROLL BEARINGS*
FOR MODERN INDUSTRY

STAINLESS STEEL MAKES THE DIFFERENCE

...its effect on modern equipment

Sanitation . . . easy maintenance . . . inherent cleanliness . . . ready adaptability to a host of different shapes and forms—these are a few of the reasons why more and more designers of food processing, dairy and beverage equipment specify stainless steel.

You'll find it in tubing, tanks, bulk coolers, autoclaves and dozens of other vital pieces of equipment in many different industries.

Stainless steel's superior resistance to corrosion . . . ready availability in scores of work-saving standard shapes adaptable to many needs . . . ease of machining, forming, joining and casting combine to give equipment producers greater freedom of design.

For more information about stainless steel and its growing effect on equipment design and selling problems, see your stainless steel supplier or write ELECTROMET—leading producer of more than 100 alloys for the metal industries, including chromium and manganese used for making stainless steels.

ELECTRO METALLURGICAL COMPANY
A Division of
Union Carbide and Carbon Corporation
30 E. 42nd Street UCC New York 17, N. Y.

METALS DO MORE ALL THE TIME . . . THANKS TO ALLOYS

Electromet
TRADE-MARK

Sanitation is a powerful selling tool in the beverage, food processing and dairy fields. That's why the use of sanitary, easy-to-clean stainless steel is growing so fast.

Why designers specify FLEXLOC self-locking nuts

Where products must be tough . . . must stand up under vibration, shock and abuse . . . designers specify rugged, reliable, precision-built FLEXLOC self-locking nuts as fasteners.

HERE'S WHY:

FLEXLOC locknuts are strong: tensile strengths far exceed accepted standards. They are uniform: carefully manufactured to assure accurate, lasting spring tension in the flexible locking collars. And they are reusable: rough screw threads, repeated removal and replacement, frequent adjustments will not affect their locking life.

Standard FLEXLOC self-locking locknuts are available in a wide range of standard sizes and materials, to meet the most critical locknut requirements. Your authorized industrial distributor stocks them. Write us for complete catalog and technical data. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

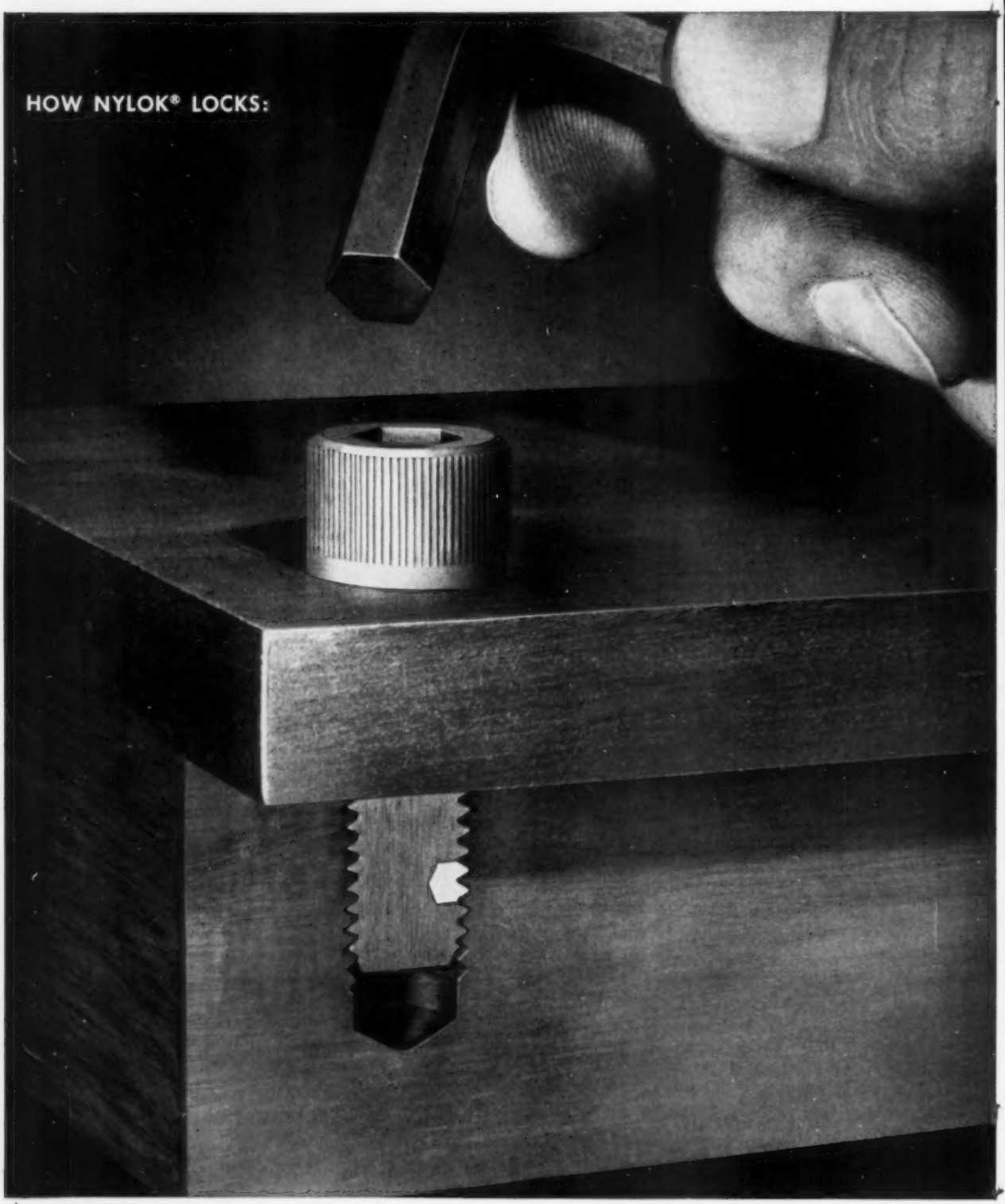
FLEXLOC® LOCKNUT DIVISION

STANDARD PRESSED STEEL CO.

SPS

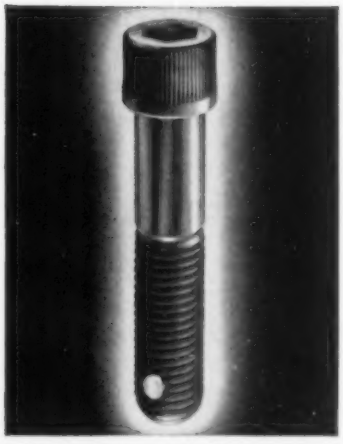
JENKINTOWN PENNSYLVANIA

NEW—self-locking UNBRAKO



LOCKED! The tough, resilient nylon pellet keys itself into the mating threads. It forces threads together and locks the screw securely.

socket head cap screws



Self-locking UNBRAKO socket head cap screw.

BEFORE ASSEMBLY. The nylon pellet projects slightly. When assembled, threads will be impressed into it.

AFTER REMOVAL. "Plastic memory" of pellet has expanded impressed threads to greater diameter than screw threads. Screw can be used repeatedly. In use, "memory" keeps threads tightly locked.

They won't work loose. And they simplify design and save production time.

UNBRAKO socket head cap screws are now available embodying the Nylok* self-locking principle. Nylok provides the first truly practical solution to the problem of making cap screws self-locking.

An UNBRAKO cap screw with Nylok is a single self-locking unit. No auxiliary locking devices are needed. Just thread the UNBRAKO into any tapped hole. *Seated or not*, it locks positively wherever wrenching stops. The tough, resilient nylon pellet forces mating threads together and holds tight. The screw will not work loose.

You save production time when you make products with self-locking UNBRAKOs. And you get greater simplicity in design with less bulk and weight. The number of parts you must assemble to achieve full locking action is reduced to the absolute minimum. Lockwashers under screw heads are no longer necessary. Costly wiring of cross drilled heads is eliminated. And in many cases you will save weight and mass by using shorter screws in tapped holes instead of drilling through and using nuts and lockwashers.

Self-locking UNBRAKOs are reusable. They have uniform locking and installation torques—with no galling or seizing on mating threads. They successfully withstand temperatures from —70° to 250°F. And, when screws are properly seated, the locking pellet also functions as a liquid seal.

A complete line of self-locking UNBRAKO socket screw products, in a wide range of standard sizes, materials and finishes, is available through your authorized industrial distributor. Technical data and specifications are detailed in Bulletin 2193. Write us for your copy today. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

See us at the Design Engineering Show, May 20 to 23, New York Coliseum, Booth #416

UNBRAKO SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

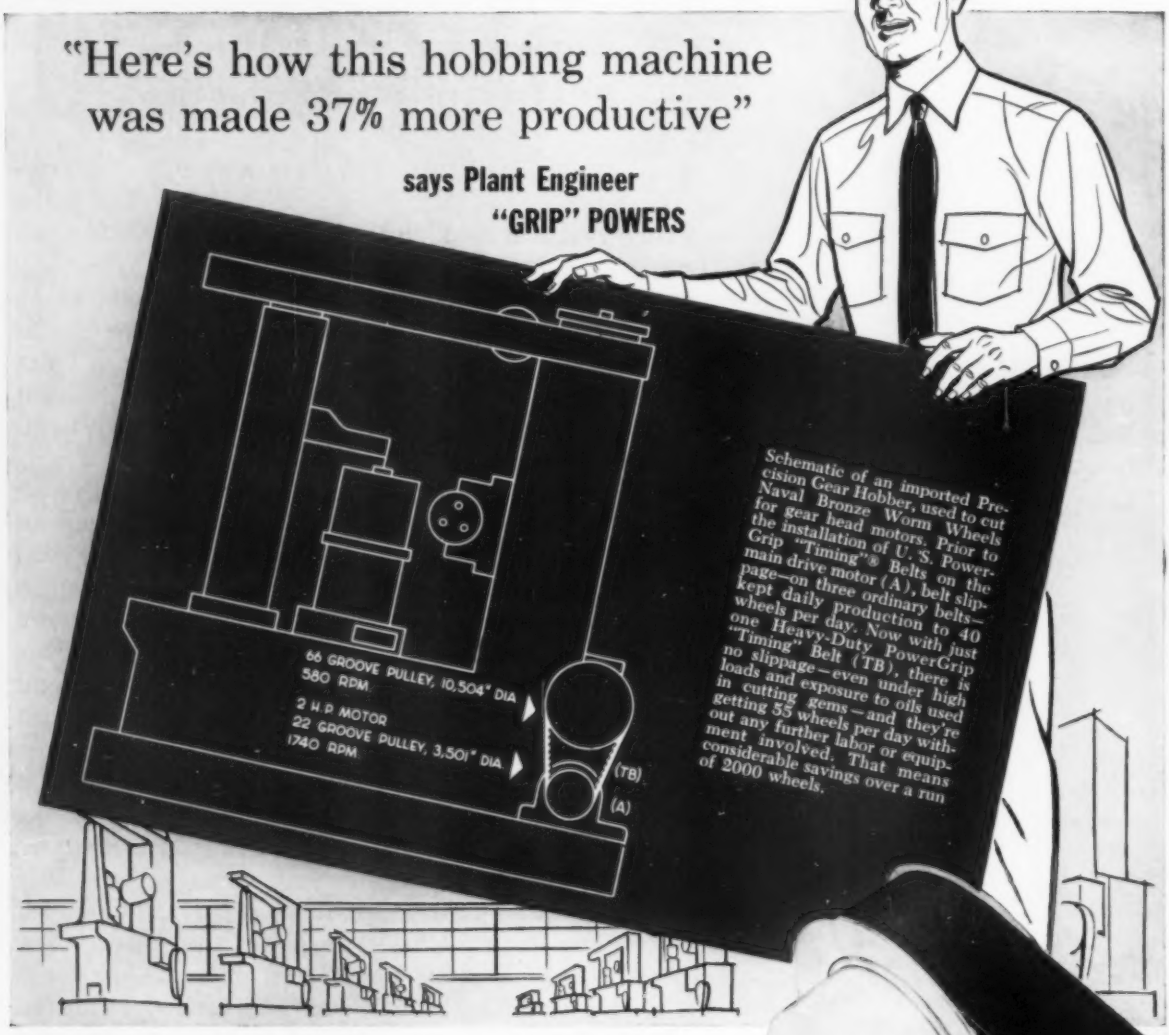
SPS

JENKINTOWN PENNSYLVANIA

US RUBBER **PowerGrip** "TIMING" BELTS

"Here's how this hobbing machine was made 37% more productive"

says Plant Engineer "GRIP" POWERS



Schematic of an imported Precision Gear Hobber, used to cut Naval Bronze Worm Wheels for gear head motors. Prior to the installation of U. S. PowerGrip "Timing"® Belts on the main drive motor (A), belt slippage—on three ordinary belts—kept daily production to 40 wheels per day. Now with just one Heavy-Duty PowerGrip "Timing" Belt (TB), there is no slippage—even under high loads and exposure to oils used in cutting gems—and they're getting 55 wheels per day without any further labor or equipment involved. That means considerable savings over a run of 2000 wheels.

"Grip" Powers is showing you a true story of how one East Coast gear manufacturer utilized the unique ability of U. S. PowerGrip "Timing" Belts to step up production. It's just one of many examples of how U. S. PowerGrip "Timing" Belts simplify and improve a power transmission unit.

For the design of hand tools, drill presses, saws, electric typewriters—from fleapower to 1,000 horsepower—get U. S. PowerGrip "Timing" Belts.

These belts—plus expert engineering service—are obtainable at the 28 "U. S." District Sales Offices, "U. S." power transmission distributors, or contact us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

U. S. PowerGrip "Timing" Belts offer all these advantages:

- close to 100% efficiency.
- constant angular velocity.
- imbedded with steel cables for high tensile strength.
- no slippage, no take-up—allows short centers, high ratios.
- absence of metal-to-metal contact—eliminates need for lubrication and housing devices.
- handles speeds up to 16,000 F.P.M. or so slow as to be imperceptible to the eye.

Visit our Booth #822, Design Engineering Show, New York Coliseum, May 20-23

US RUBBER **Mechanical Goods Division**

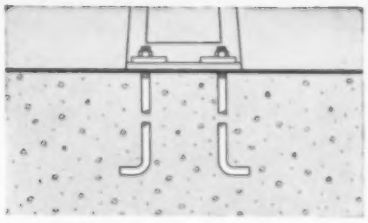
United States Rubber

Where Do All the Anchor Bolts Go?

Something the motorist never sees, and hardly ever thinks about, are the long hook bolts which, in their unobtrusive way, anchor the electric light standards found along boulevards and highways. The bolts, generally used in groups of four, are embedded in concrete, where they provide adequate anchorage indefinitely.

Nor are hook anchor bolts limited to this one use. They also anchor transmission towers and bridges, and support signs at service stations and parking areas; they fasten structural steel to concrete foundations, and machinery to factory floors. We turn them out in a wide range of styles: all diameters from ¼ in. to 4 in., and in almost any length.

A highly specialized product, Bethlehem hook anchor bolts are representative of the ability of our fastener plant at Lebanon, Pa., to produce just about any type of headed or threaded fastener imaginable. Our fasteners engineers have a vast backlog of experience in handling the unusual in fastener problems—that's why they are frequently able to come up with solutions which add up to a saving for the user.



If you have a fastener problem which has been causing difficulty, we suggest you put it up to our fasteners engineers. Just drop a line to the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

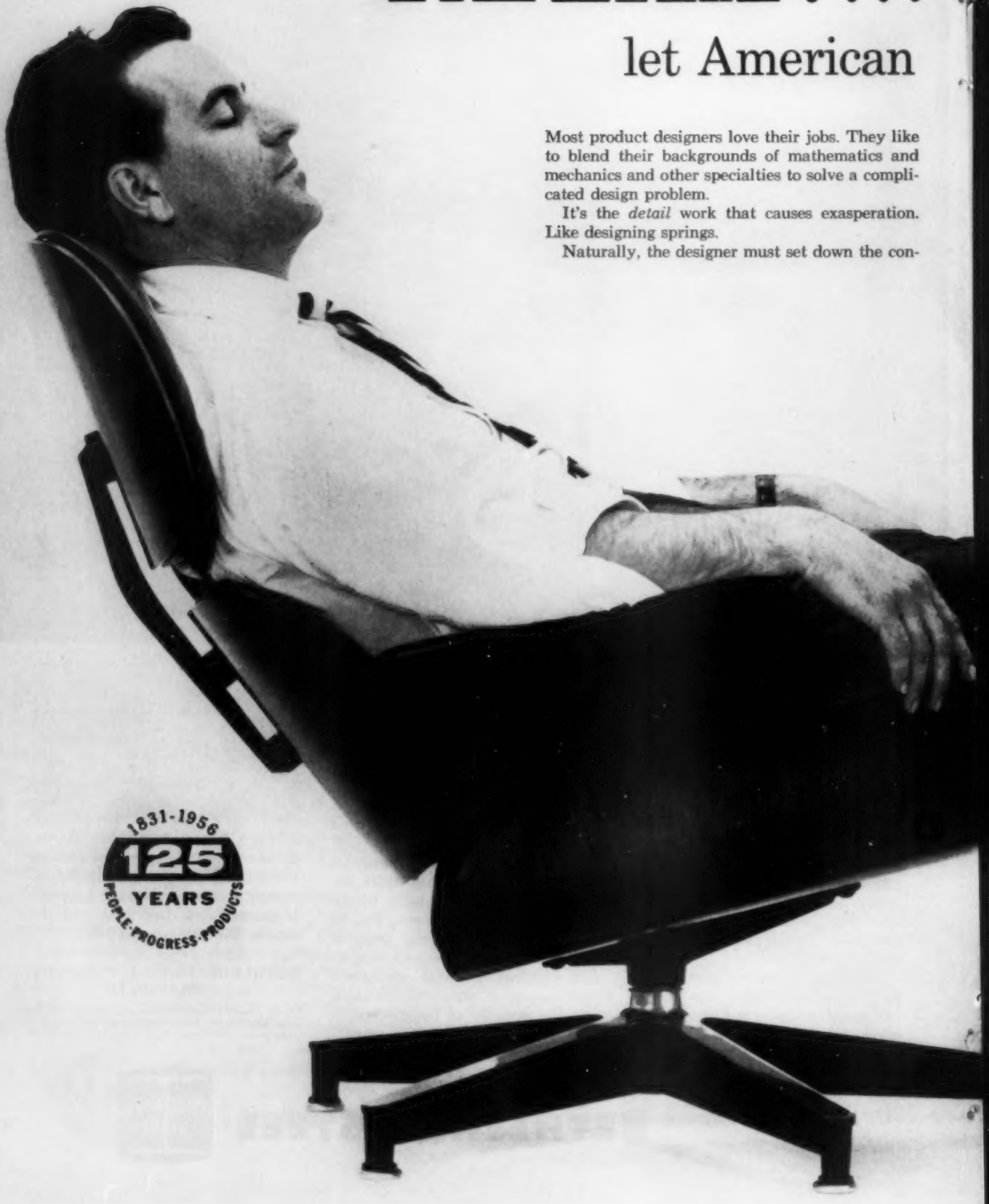
RELAX!...

let American

Most product designers love their jobs. They like to blend their backgrounds of mathematics and mechanics and other specialties to solve a complicated design problem.

It's the *detail* work that causes exasperation. Like designing springs.

Naturally, the designer must set down the con-



1831-1956
125
YEARS
PEOPLE · PROGRESS · PRODUCTS

when you have a spring problem Steel & Wire worry *for* you

ditions of use. He knows how much stiffness he wants, what fastening system is desirable, the limits of spring travel, corrosion conditions and the like. Now, the plot thickens. Can such a spring be produced, in quantity, at a reasonable price?

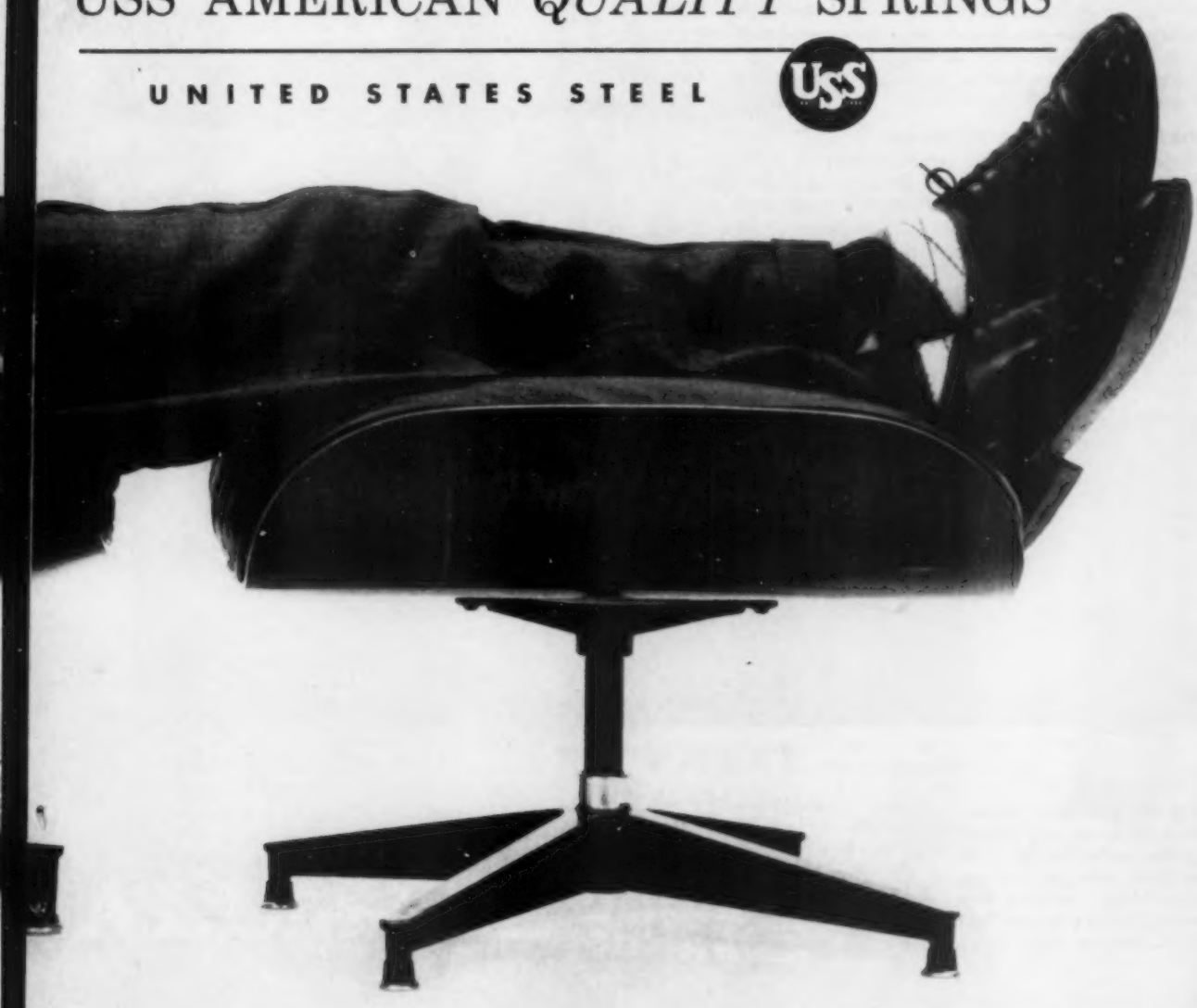
It is a rare designer who has concerned himself with these practical spring production problems. For this reason, American Steel & Wire maintains a staff of *spring engineers* to relieve you of this detail. They may be able to suggest a minor design change, or a different grade of steel, or a different finish that will give you a better spring than you contemplated at a decided savings in cost.

Just call your AS&W salesman.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN *QUALITY* SPRINGS

UNITED STATES STEEL



NEW Accopac asbestos materials cut gasket costs 15 to 30%

Your asbestos gasketing costs may be cut by as much as 30% with the new Accopac® asbestos materials made by Armstrong.

These new materials are beater-saturated with your choice of synthetic rubbers. They're tough and flexible, won't crack or pipe on bending. They die-cut cleanly. And they seal perfectly at flange pressures as low as 2,000 psi.

Brief specifications on the new Accopac materials are given below. For more detailed information—and samples—write to Armstrong Cork Company, Industrial Division, 7005 Irvin St., Lancaster, Pa.

Armstrong Accopac Asbestos Compositions

General Information

Accopac asbestos materials are made by a patented modification of the beater saturation process. Although they are typical Armstrong quality, they're inexpensive because they are made by an exclusive formulation in continuous rolls—literally by the mile.

In the Accopac process, individual fibers are coated with a synthetic latex binder before the sheet is formed. The result is a strong, homogeneous material. Even in very thin gauges, Accopac asbestos sheets are tough and flexible.

Characteristics and Uses

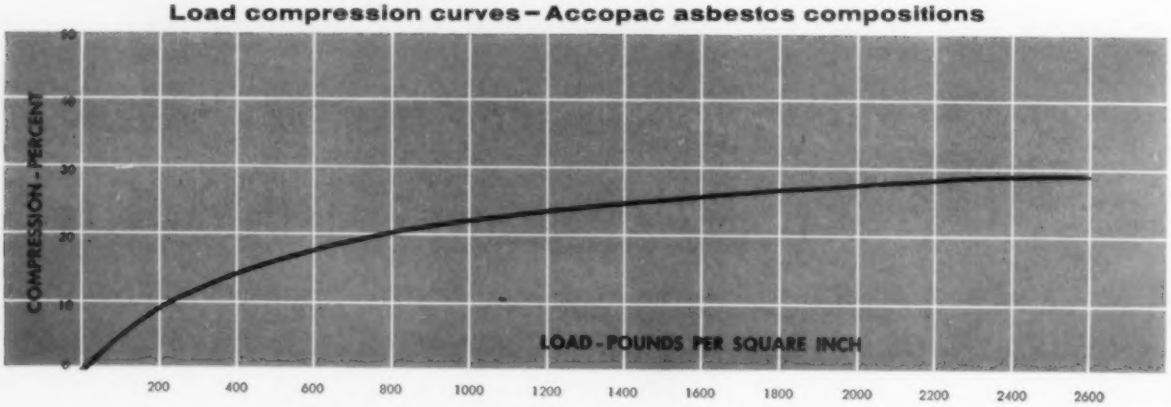
Accopac asbestos materials are recommended for moderate to heavy-duty service. They should be considered for applications where compressed asbestos sheets are now being used.

To provide resistance against a wide variety of oils, solvents, chemicals, and gases, Accopac asbestos sheets are offered with a choice of synthetic latex binders including styrene-type (Buna S), nitrile-type (Buna N) and chloroprene-type (neoprene).

All Accopac asbestos sheets are moderately compressible. They will seal at flange pressures as low as 2,000 psi.

TYPE	BINDER	TENSILE STRENGTH MINIMUM PSI AMD	PER CENT COMPRESSIBILITY
AS-428	Styrene-type rubber (Buna S)	1200	17-27 (1000 psi) 30-40 (5000 psi)
AD-838	Chloroprene-type synthetic rubber (neoprene)	1200	
AN-859	Nitrile-type synthetic rubber (Buna N)	1700	

Load compression curves—Accopac asbestos compositions



You'll find more helpful information on the whole line of Accopac fiber sheet gasket materials in this new folder. Write for your copy today. Address Armstrong Cork Company, Industrial Division, 7005 Irvin St., Lancaster, Pa.

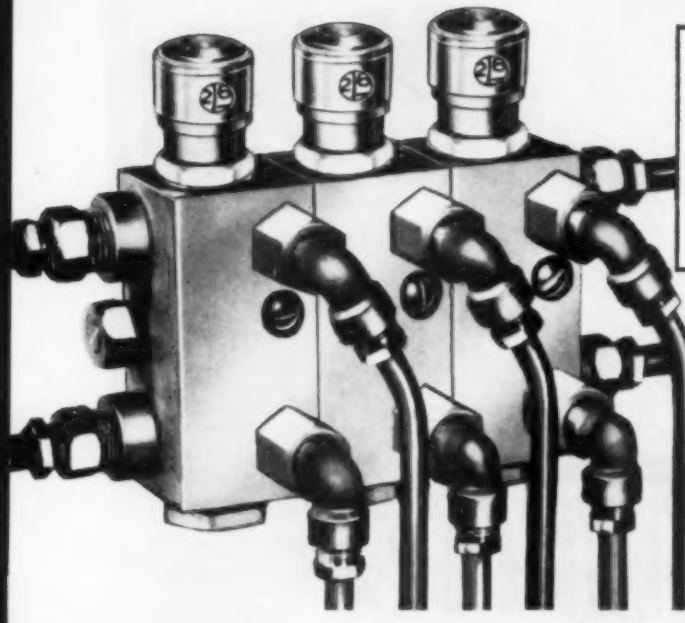
Armstrong ACCOPAC

. . . used wherever performance counts

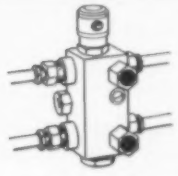
Design to meet
Toughest lubrication requirements

with this centralized
ALEMITE ACCUMATIC SYSTEM

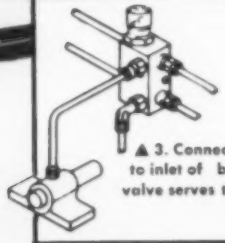
Can be designed into any machine in 4 easy steps!



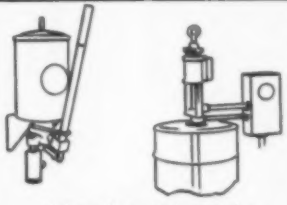
1. Remove grease cups or grease fittings.



2. Connect each valve in system to its two lubricant supply lines.



▲ 3. Connect valve outlets to inlet of bearings. (Each valve serves two bearings.)



4. Provide central pump for supplying lubricant to system.

Type II Accumatic Valve

Handles difficult multiple-bearing lubrication under all conditions. Fully sealed for clean lubrication of power shovels, cement kilns, conveyors—any outdoor or indoor installation. Operates whether completely immersed in fluid . . . covered by dirt or grit . . . or protected by anti-corrosive paint. For fluid oil or light grease. Four sizes, delivering from .050 to .500 cu. in. of lubricant. Fully hydraulic—no springs to adjust or replace.

Now available with Lubrication Recording Cycle Counter—for a fully automatic record of bearing lubrication!

Tests show no appreciable variation in the amount of lubricant discharged after 73,312 cycles—equal to *122 years of twice-a-day service!*

ALEMITE ACCUMATIC ADVANTAGES!

- Prevents application of wrong lubricant.
- Seals completely against damaging dirt, grit and water.
- No parts are neglected—lubricates inaccessible and dangerous bearings at regular intervals.
- Eliminates product spoilage due to over-lubrication.
- Eliminates point-by-point lubrication methods—services all bearings in one operation.
- Delivers exact amount of lubricant to bearing.

ALEMITE
REG. U. S. PAT. OFF.
Division of STEWART-WARNER CORPORATION

STEWART SW WARNER

FREE! Alemite Accumatic Catalog

ALEMITE, Dept. AA-57
1850 Diversey Parkway, Chicago 14, Illinois
Please send me my free copy of the complete Accumatic Catalog.

Name .....
Company .....
Address .....
City ..... Zone ..... State .....

For fast, cold sandwich bonding ...3M Adhesive EC-1357

NIP ROLLER OR COLD PRESS COMPLETES STRONG, LIGHTWEIGHT SANDWICH PANELS WITH EC-1357. YOU NEED NO HEATED PRESSES.

Gain the speed and economy of cold bonding! Fabricate sandwich panels for non-load bearing uses with 3M Adhesive EC-1357.

This high-strength, flexible adhesive bonds sandwich panels without clamps or heated presses. You force-dry the solvent out of the adhesive before bonding. Cold press or nip roller finishes the job. You get maximum immediate strength. And EC-1357 builds up even more strength with age as it cures at room temperatures.

Because it is dark in color, EC-1357 absorbs drying heat fast. Thus it cuts production time, allows continuous movement from adhesive spraying to finished panel. EC-1357 resists moisture and normal temperatures, too. For load-bearing panels, investigate 3M Adhesive EC-1177.

SEE WHAT 3M ADHESIVES CAN DO FOR YOU!

Consult 3M research. Contact your 3M Field Engineer. Or for information and free literature, write on your company letterhead to: 3M, Dept. 75, 417 Piquette Ave., Detroit 2, Mich.

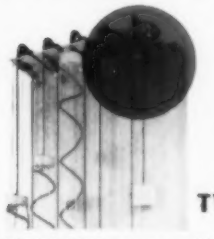
PRODUCT OF 3M COMPANY RESEARCH

MINNESOTA MINING AND MANUFACTURING COMPANY · ADHESIVES AND COATINGS DIVISION

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N.Y. 16, N.Y. • CANADA: P.O. BOX 757, LONDON, ONT.

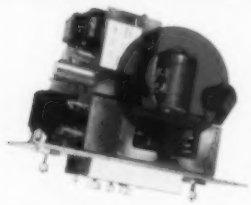
NEWLY DESIGNED

Howard Induction Motor Model 2900 Offers 18% Overall Improved Performance and Efficiency for Critical Applications



MERIAM MULTIPLE TUBE COMMON WELL TYPE MANOMETER

Model 2900 motors with gear units are used to motorize each well, quickly position the datum level required for the pressure range of the test involved.



MAGNECORD TAPE RECORDERS

Model 2900 is used in several MAGNECORD high fidelity professional units. Extremely quiet operation, minimum cogging, minimum mechanical vibration are major points in selection.

WESTERN UNION RECORDER #5616B

Mfd. by J. P. Seeburg Corp.

Model 2900 motors maintain an exactly constant speed, are extremely quiet and dependable. Selected by Western Union for their Recorder #5616B that transmits and receives messages from users office to Western Union office.

MODEL 2900—2 pole, 4 pole, 6 pole, 8 pole, 1, 2, or 3 phase and split phase applications. 1/100 to 1/15 h.p.

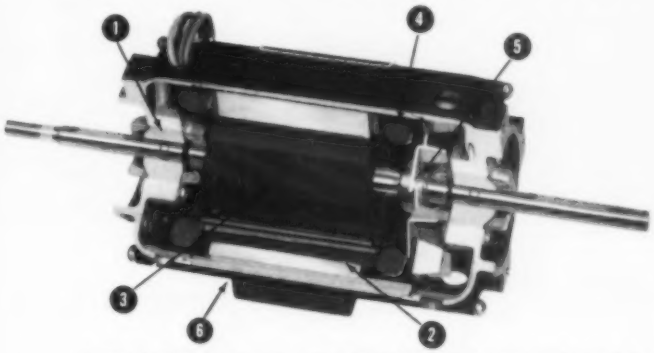
The applications shown above are just three of many applications now served by HOWARD MODEL 2900 motors.

The new HOWARD 2900 motor incorporates completely redesigned magnetic and electric circuits with increased stator and rotor slots, 24/20 slot lamination as against 16/14 slot lamination in the old 2900 design. The advantages are as follows:

- Six pole 2900 motors in Induction, Hysteresis and Torque types are now available. Of particular importance is the new six pole Torque motor which operates with extreme smoothness and practically no detectable variation of stalled torque throughout a rotor revolution. Almost perfect linearity in the speed-torque curve has been achieved at speeds varying from 0-1000 RPM.
- The new Reluctance Synchronous 2900 motor becomes suitable for many critical operations (in particular, tape recorders) where only expensive Hysteresis units were previously conceivable. Reduction of the external field permits the motor to be used without magnetic screening.
- The new 2900 design will permit operation of motor on 3 phase, 60, 180 and 400 cycle, 2/4/6 poles.
- The efficiency and power factor have been improved by an average of 20%. Heat rise is considerably lower which results in: a. Longer Motor Life b. Longer Bearing Life c. Minimum lubrication trouble d. Ability to operate in higher ambients
- There is substantially less mechanical vibration.
- There is less electrical and mechanical noise.

At request all 4 and 6 pole motors can be made reversible in motion.

Prices on the new Howard 2900 motor are moderate. Many gear ratios are available. Write today for complete information on MODEL 2900 and other Howard Induction motors, Series and D. C. motors and Shaded Pole motors. Howard's fractional h.p. motor selector chart is available on request.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors provided with ball thrust bearing for vertical operation.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formvar insulated wire, impregnated and baked with top grade electrical varnish.
5. Internal fan for cooling. 6. The case is a sturdy rigid casting.

Other Howard motors: UNIVERSAL & D.C. 1/200 to ½ h.p. • SHADED POLE 1/2000 to ⅓ h.p. • INDUCTION 1/1400 to ⅓ h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

HOWARD

HOWARD INDUSTRIES, INC., 1750 STATE ST., RACINE, WIS.

SALES OFFICES: 208 S. La Salle St., Chicago 4

942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1

Buy Defense Bonds

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION CYCLOHM MOTOR CORPORATION RACINE ELECTRIC PRODUCTS

structurally homogeneous

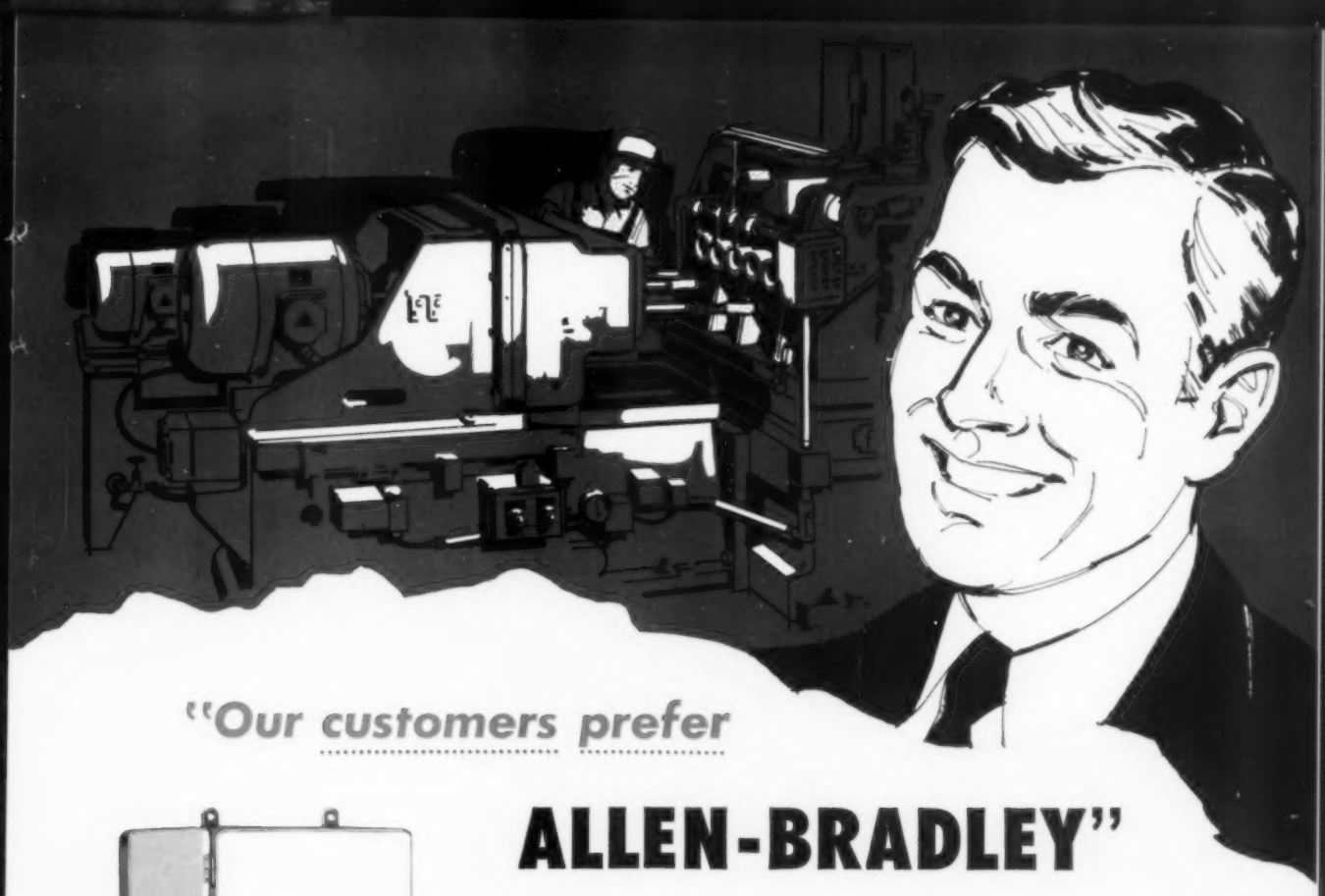
PARKER-KALON stress relieved socket screws

After controlled heating and equally controlled uniform quenching imparting maximum strength, P-K Socket Screws are carefully tempered to assure ductility, proper elongation and high impact strength. This is your assurance that . . . *If it's P-K . . . It's O-K!*

PARKER-KALON DIVISION, General American Transportation Corporation • Manufacturers of Socket Screws, Self-tapping Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws.

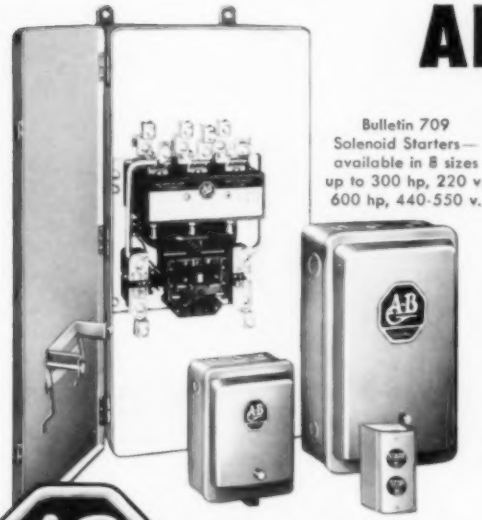
Sold Everywhere Through Leading Industrial Distributors — Factory: Clifton, New Jersey • Warehouses: Chicago, Illinois; Los Angeles, California

PARKER-KALON® fasteners



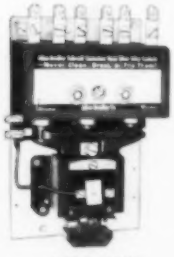
"Our customers prefer

ALLEN-BRADLEY"



Bulletin 709
Solenoid Starters—
available in 8 sizes
up to 300 hp, 220 v;
600 hp, 440-550 v.

A-B Quality



Bulletin 702
Solenoid Contactor
Size 3

Bulletin 702
Solenoid Contactor
Size 1

Bulletin 700
Solenoid Relay

Bulletin 800T
Oiltight Push Button

Bulletin 800T
Oiltight Selector Switch

Among leading manufacturers of machine tools, Allen-Bradley Quality motor starters are the favorite—as shown by many independent preference studies. Having the Allen-Bradley Quality trademark appear on your equipment means automatic customer acceptance.

The "simple design" of Allen-Bradley motor control . . . with only *one* moving part . . . guarantees reliable operation. The double break, silver alloy contacts—used in all Allen-Bradley controls—are always in perfect operating condition. Even inspection time—let alone maintenance time—is saved.

No matter what your control requirements may be, they can be met with standard components listed in the Allen-Bradley Handy Catalog . . . Allen-Bradley control specialists can help you with your control problems. *Standardize* on Allen-Bradley Quality motor control . . . add this sales asset to your production machines!

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

5-57-R

for reliability... plus consistent operation

SPECIFY Allen-Bradley

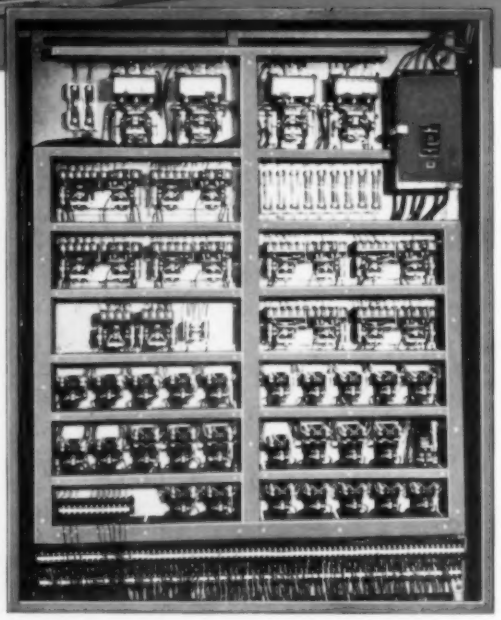
BARNESDRIL
Duplex type honing machine, for honing V-8 motor blocks, equipped with a special Allen-Bradley control panel.

The motor controls on your automatic machines must be reliable when the machines are new . . . and remain reliable when the machines are old. When the sequence of operations is short, the controls must be instantaneous and consistent in their operation . . . or production has to be slowed down to the maximum variation in time of contactor operation. Sluggishness of a single component . . . even for a split second . . . may mean costly repairs and work spoilage.

Reliability is an integral part of all A-B motor controls. The simple solenoid design . . . with only one moving part . . . assures millions of trouble free operations. The double break, silver alloy contacts never need service attention.

Let Allen-Bradley help you with your special control problems. As you know, "quality" and "cheap" are two "teams" never in the same league.

Please send for the new Allen-Bradley Handy Catalog.



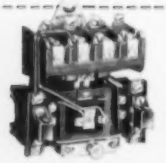
Motor control panel for a Barnesdril honing machine made from standard Allen-Bradley control units listed in the Allen-Bradley Handy Catalog.

5-57-R

A-B Quality

BULLETIN 849
"On-Delay"
Pneumatic Timer

BULLETIN 802T
Adjustable Lever
Oiltight Limit Switch



BULLETIN 709
Automatic
Solenoid Starter

BULLETIN 700
Universal Type
Solenoid Relay

BULLETIN 800T
Oiltight Push Button
Station

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

Rigidity! At equal weight, magnesium is 18 times stiffer than steel

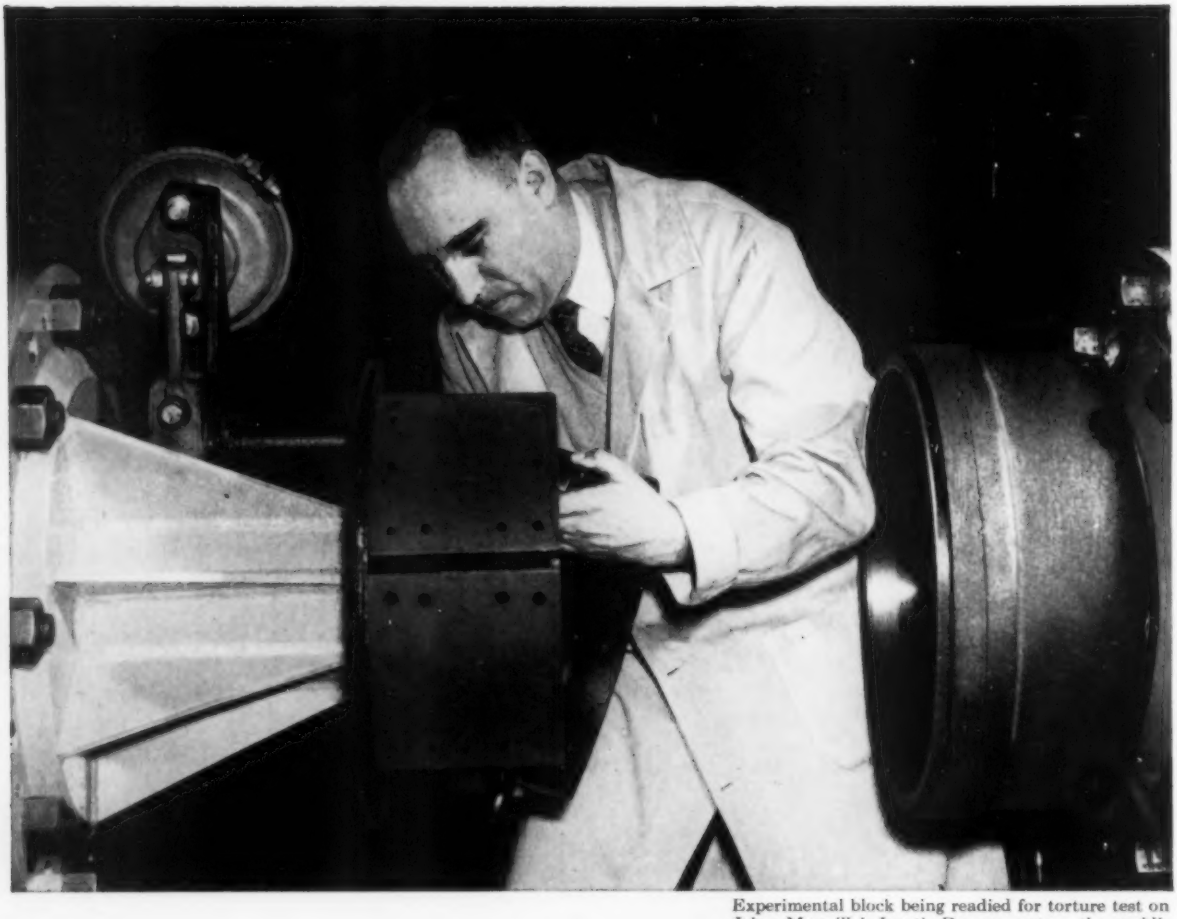
Magnesium's unique combination of strength and light weight gives it some outstanding abilities as a structural metal. Take rigidity, for example. A magnesium bar has 22% the stiffness of a steel bar of the same dimensions.

But stiffness increases as the cube of section thickness. So, if thickness of the magnesium is increased to twice that of the steel, the magnesium bar will be over 70% more rigid—yet weigh only half as much. And if thickness is further increased until the bars are of equal weight, the magnesium bar will be 1878%—or over 18 times—more rigid!

Similarly, a magnesium bar of equal rigidity to an aluminum bar will weigh only 75% as much as the aluminum bar. At equal weight, the magnesium bar will be over twice as stiff.

From these facts it's easy to see that magnesium can do a structural job equal to or better than steel and aluminum—and with appreciable savings in weight—whenever it's practical to increase section thickness. For more information contact the nearest Dow sales office or write to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Department, MA 1402H.

YOU CAN DEPEND ON DOW



Experimental block being readied for torture test on Johns-Manville's Inertia Dynamometer—the world's largest unit designed for friction material testing.

Man in charge of putting more mileage into J-M Brake Blocks

Creating new and better brake blocks is a never-ending responsibility of J-M engineers. Working with the very latest in scientific development equipment, these men are blazing new trails in improved friction material performance.

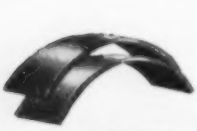
Over the years, Johns-Manville has offered a wide choice of thoroughly proved, high-quality, high-performance brake linings, brake blocks and clutch facings. This superiority stems from engineering and production techniques that assure uniformly highest quality. These techniques also provide volume production, rapid delivery and lowest unit cost.

Chances are a J-M material incorporating all the properties you need for your friction applications is already available. If not, let us help you find the solution. The Johns-Manville engineering staff, a superbly equipped development laboratory, and skill gained through 99 years of manufacturing experience, are at your service.

Your Johns-Manville Representative will gladly tell you more about this service, or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville



Molded and Woven Brake Linings

Molded and Woven Clutch Facings

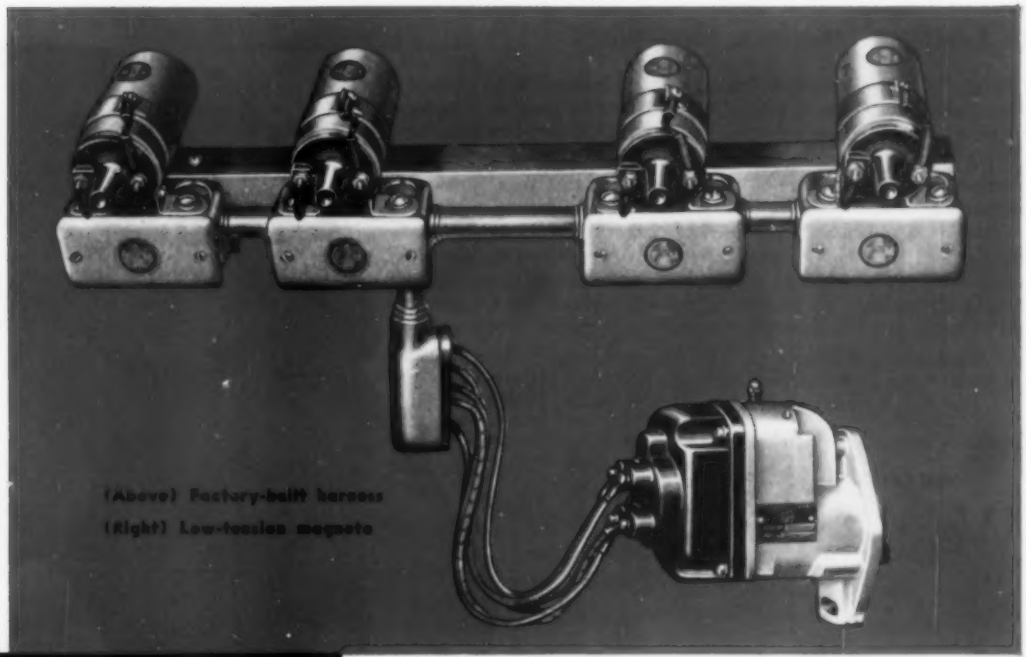
Molded Brake Blocks

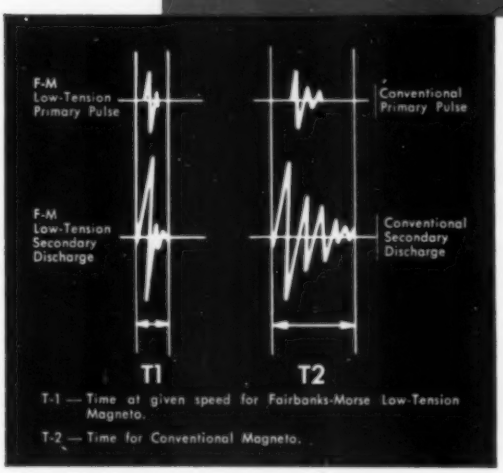
Molded Segments for Automatic Transmissions

Woven Transmission Band Linings

New LOW-TENSION ignition systems

improved firing gives longer service on 1, 2, 4, 6, 8 - cylinder spark-ignited engines



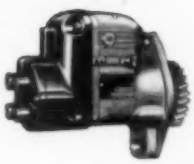

F-M Low-Tension Primary Pulse
Conventional Primary Pulse
F-M Low-Tension Secondary Discharge
Conventional Secondary Discharge
T1
T2
T-1 — Time at given speed for Fairbanks-Morse Low-Tension Magneto.
T-2 — Time for Conventional Magneto.

New model engines with their higher compression ratios, as well as thousands of engines already in the field, all show vastly improved performance with the Fairbanks-Morse low-tension ignition system. The short duration, high peak voltage spark liberates more than enough energy (heat) to ignite a full charge under all engine operating conditions.

Bearings and other magneto parts last longer because there is no problem with ozone or high corona discharges within the magneto case. In addition, a major improvement in spark plug life results from reduced electrode erosion due to the shortened voltage-time characteristic.

Fairbanks-Morse low-tension magnetos are no larger than standard units, thus simplifying installation. Complete factory-built harnesses that include transformers, junction boxes, mounting hardware, lead wires, etc. are available for nearly all popular engines up to 4000 cu in. in displacement.

MORE THAN 4,000,000 MAGNETOS IN USE



FAIRBANKS-MORSE

A name worth remembering when you want the BEST

MAGNETOS • REWIND STARTERS • WATER SYSTEMS • GENERATING SETS
PUMPS • MOTORS • SCALES • DIESEL LOCOMOTIVES AND ENGINES

Fairbanks, Morse & Co., Magneto Division
Beloit, Wisconsin

Please send Bulletin FM238A describing the Fairbanks-Morse low-tension ignition system.

Name_____

Company_____

Address_____

City_____ State_____

CAKE MIX IN A "JIFFY" WITH

CYPAK

Controlling automatic storage conveyors at Chelsea's modern food plant

Chelsea Milling Company, maker of well-known "Jiffy" brand premixed foods, uses flexible CYPAK* static control to reduce material handling costs in their plant at Chelsea, Michigan.

CYPAK begins at the mixing and packaging machines, memorizing the sequence of cartons going to the warehouse. Cartons are identified automatically, and then CYPAK directs storage according to the preselected pattern.

Subsequent delivery of cartons from storage to dock is also completely predetermined, making the warehousing operation totally automatic. An additional benefit realized by Chelsea with this system has been great reduction in carton breakage.

For complete information on CYPAK, call your Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

*Trade Mark

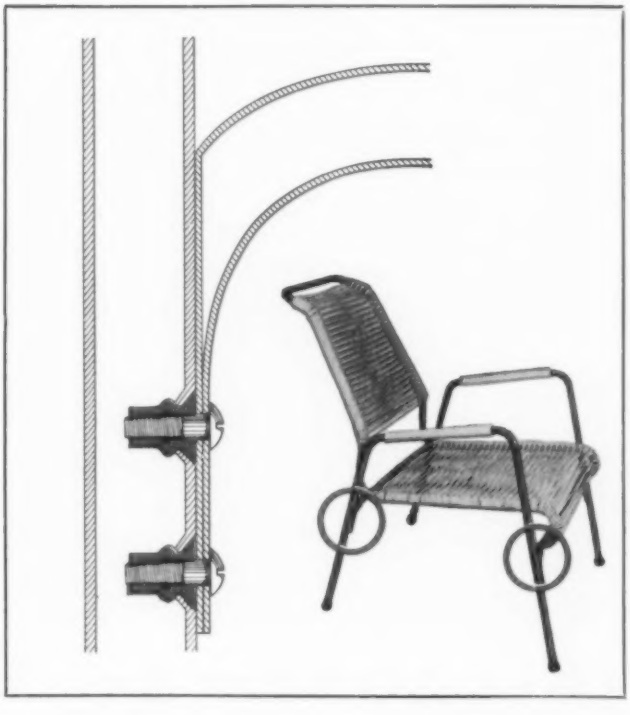
J-22033

YOU CAN BE SURE... IF IT'S

Westinghouse

Mr. Lester L. Bosch, Partner, Bosch & La Tour views their system design.

Only B.F. Goodrich Rivnuts® give you firm, blind nutplates for tubular applications!



Finding a fastener that would preserve the clean, functional lines of their modern tubular furniture was a problem for the O. Ames Company. Stove bolts and screws projecting from the legs were not only unsightly, but were a major sales deterrent to a woman in 51 gauge nylons.

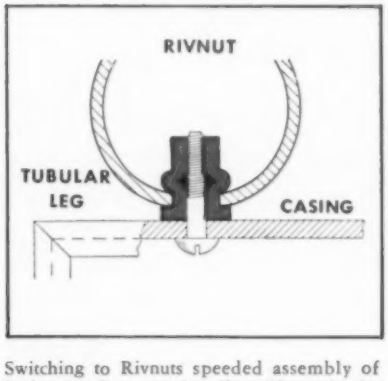
B. F. Goodrich Rivnuts provided the answer to this problem. Upset inside the tubular legs, Rivnuts with countersunk heads fit flush, take round headed attachment screws. In addition, Rivnuts hold firmly and permanently because the bulge in the Rivnut shank conforms to the curvature of the tube. Rivnuts are installed by one man in seconds, and provide an accurate nutplate for quick assembly of the finished product.

If you want to do a smoother fastening job, or are looking for ways to fasten faster and at less cost, use B. F. Goodrich Rivnuts.

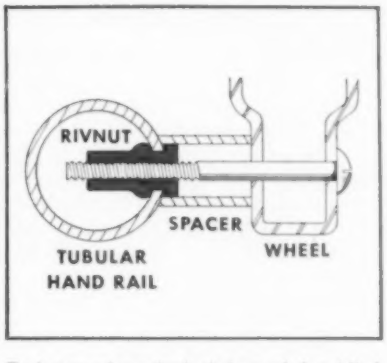
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to B. F. Goodrich Rivnuts, Dept. PE-57, Akron, Ohio.

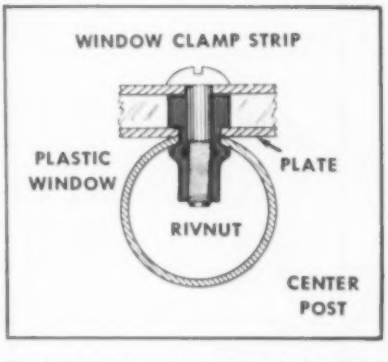
Rivnuts solve a variety of tubular fastening problems like these



Switching to Rivnuts speeded assembly of barbecues. One man installs a Rivnut in the tubular leg in seconds. There are no boltheads to detract from the unit's clean lines. Time is saved in faster knockdown for shipping.



Designers of a wheel chair needed a blind fastener with at least 6 clean threads to serve as a nutplate. Rivnut upset inside the tubular handrail of the wheel chair provides firm, accurate, nutplate for bolt attachment to the wheels.



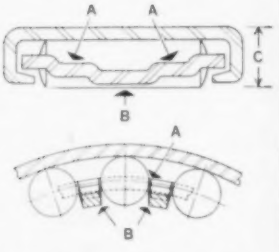
Upset Rivnut secures airplane window plate to center post. Firm bulge in shank seals weather out. Rivnut head serves as spacer for plastic window, while 6 clean threads hold clamp strip and window securely in place.

B.F.Goodrich

B.F.Goodrich Aviation Products

a division of The B. F. Goodrich Company, Akron, Ohio

Features of the new
TORRINGTON DRAWN CUP ROLLER BEARING



- rollers end-guided at pitch line (A)
- shaft-riding retainer (B) designed to permit lubricant circulation
- high capacity in small cross section (C)
- long pregreased life
- efficient at high speeds
- mounted by press fit
- simple housing design
- low unit cost

INTRODUCING

a new low-cost precision roller bearing...

THE TORRINGTON DRAWN CUP ROLLER BEARING

For the first time, the advantages of drawn cup outer race construction are available in a precision roller bearing.

This compact, lightweight bearing consists of spherical end needle rollers, a one-piece hardened steel retainer and case-hardened thin-section outer race. Designed to run on a hardened shaft or with an inner race, this new series takes a press fit in a simple housing without snap-rings or shoulders.

Highly efficient roller guidance and lubrication are outstanding features. The shaft-riding retainer contacts the roller ends at the pitch line where guidance can be obtained with the least effort. The design provides ample storage for lubricant and promotes its circulation.

These features make the new bearing particularly suited to applications requiring compactness with precision, high-speed endurance or long pregreased life.

For information on sizes now available and for application assistance, call on our Engineering Department or write for the new bulletin, "Torrington Drawn Cup Roller Bearings." THE TORRINGTON COMPANY, Torrington, Conn. — and South Bend, Ind.

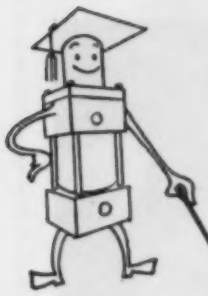
TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • THRUST • BALL • NEEDLE ROLLERS

Miller

FLUID PRESSURE BOOSTERS

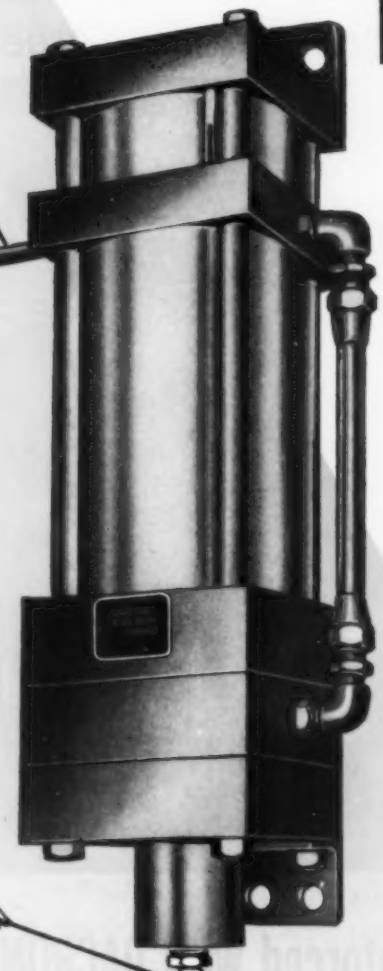


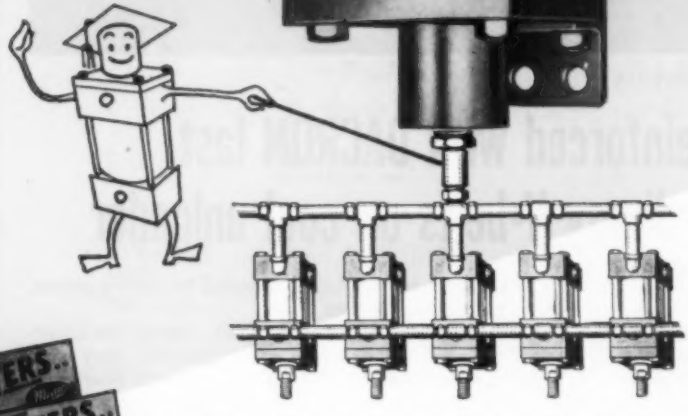
BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

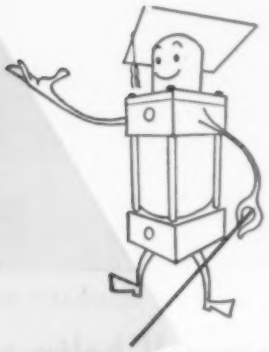
Output Range: 200 to 10,000 psi Fluid





- Save space, weight and investment cost by replacing pump installations in many applications
- Less costly to install, operate and maintain
- **Hold pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide—at point of cylinder thrust—more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute

NOTE: In addition to its most complete line of "Custom-Built" Boosters available on normal delivery, Miller offers 5" bore 25 to 1 ratio, boosters for immediate delivery in either 6" or 12" stroke. Write for data and prices.



ESPECIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

SALES AND SERVICE FROM COAST TO COAST

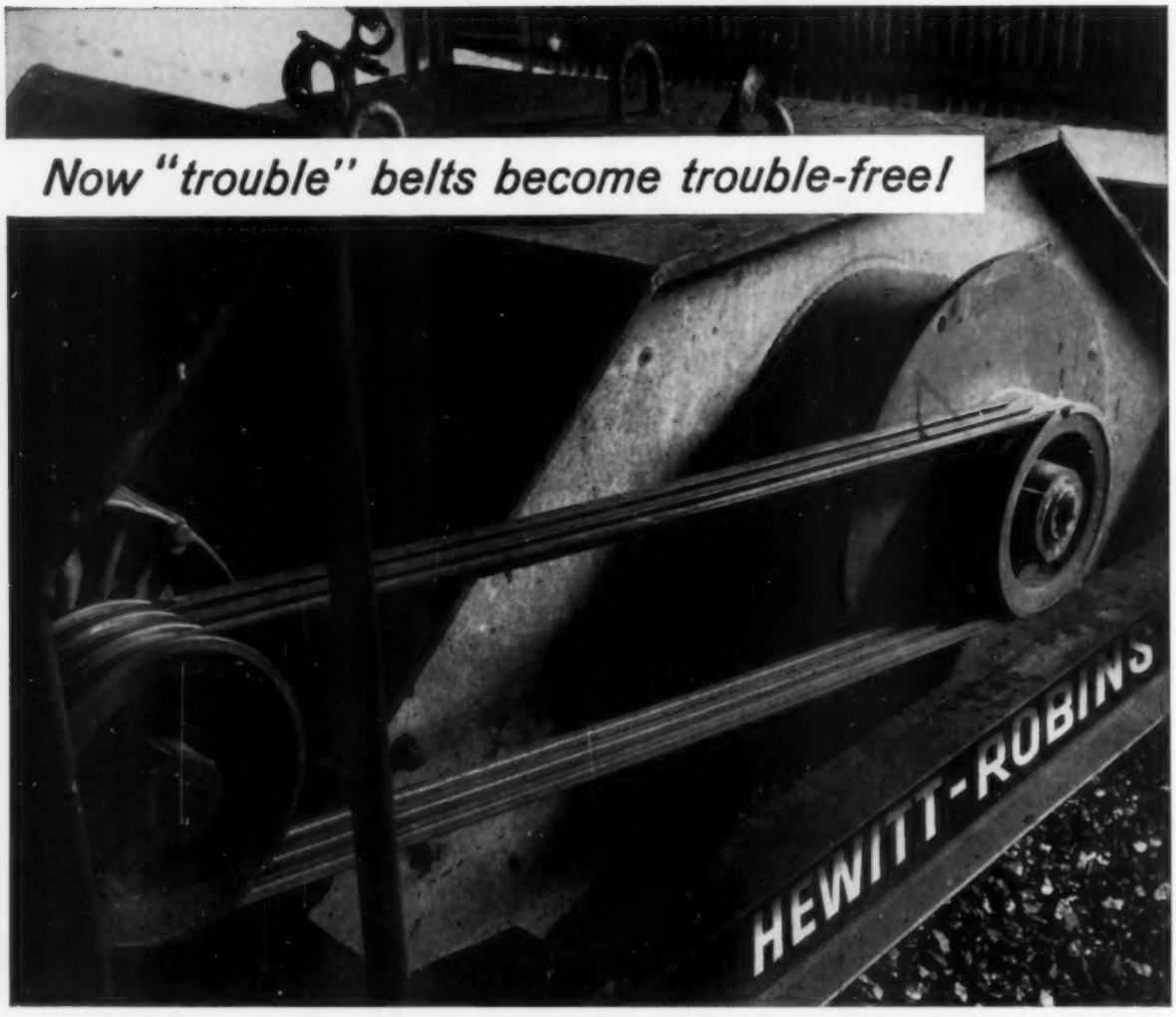
CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER FLUID POWER DIVISION
FLICK-REEDY CORP.

2002-04 N. Hawthorn Ave. • Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS



INDIANAPOLIS POWER & LIGHT COMPANY REPORTS:

Premium V-belts reinforced with DACRON last 52 times longer than ordinary V-belts on coal unloader

REG. U. S. PAT. OFF.

The Hewitt-Robins Car Shakeout in the receiving yards of the Indianapolis Power & Light Company needed new V-belts about every three weeks before its drive was switched to V-belts reinforced with "Dacron"*. In five years' operation only one belt change has been necessary—after three years' use. Despite the rugged operating conditions involved in unloading up to 30 hopper-car loads of coal a day, these belts made with Du Pont "Dacron" lasted 52 times longer than belts reinforced with conventional fiber.

The machine that uses V-belts reinforced with "Dacron" gets up to 40% more horsepower from its belt drives than is possible with other reinforcing fibers. The ability of these belts to withstand greater shock loads coupled with their longer flex life results in remarkable durability. They stretch less and are more stable than other belts . . . require far less maintenance. And design men find they can use fewer and smaller belts and sheaves, to meet today's demand for more compact, more economical belt drives.

For the next drive you design or install, consider the advantages of premium V-belts made with "Dacron". They combine the unique properties of "Dacron" polyester fiber made by Du Pont and the highest skills of leading manufacturers who make the belts. E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Department, Wilmington 98, Delaware.

**"Dacron" is Du Pont's registered trademark for its polyester fiber.*

DU PONT

REG. U. S. PAT. OFF.

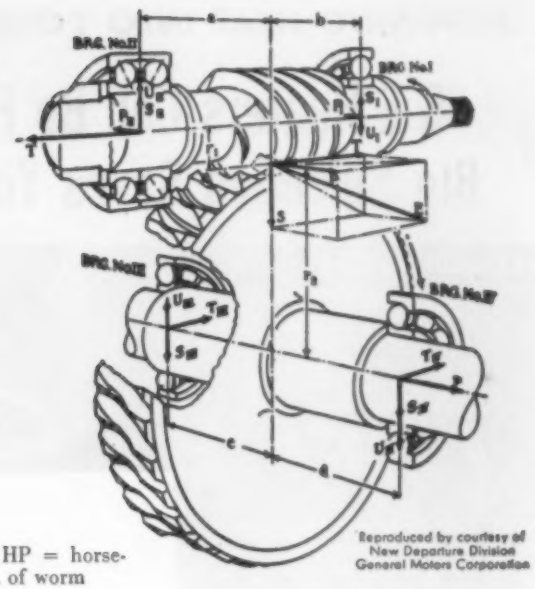
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

V-BELTS OF "DACRON" transmit more horsepower . . . stand greater shock loads . . . give longer flex life . . . give greater opportunities for machine-design improvement.

(Advertisement)

Helpful Data from
DE LAVAL

How to Calculate Worm Gear Bearing Loads



Reproduced by courtesy of New Departure Division General Motors Corporation

$Q = \frac{HP \times 63025}{N}$ = TORQUE INPUT to worm, lbs. inches; HP = horsepower transmitted and N = rev. per min. of worm

$P = \frac{Q}{r_1}$ = TANGENTIAL FORCE of worm, where

r_1 = Pitch radius of worm in inches

[r_2 = Pitch radius of worm gear

$= \frac{1}{2\pi}$ (number of teeth in gear x axial worm pitch)]

$S = \frac{P \tan \alpha}{\tan \gamma}$ = SEPARATING FORCE, where

α = Axial tooth pressure angle*

γ = Helix or lead angle of worm*

$= \tan^{-1} \frac{lead}{2\pi r_1}$, or $\tan^{-1} \frac{\text{Number of threads x axial worm pitch}}{2\pi r_1}$

$T = \frac{P}{\tan \gamma}$ = WORM THRUST, or tangent force driving worm gear

* LEAD ANGLE 0°-35° use 27½° Pressure Angle
LEAD ANGLE 35°-45° use 30° Pressure Angle

BEARING LOADS

Due to	on Brg. I	on Brg. II
P	$P \frac{a}{a+b} = P_I$	$P \frac{b}{a+b} = P_{II}$
S	$S \frac{a}{a+b} = S_I$	$S \frac{b}{a+b} = S_{II}$
T	$T \frac{r_1}{a+b} = U_I$	$T \frac{r_1}{a+b} = U_{II} = U_I$
Total Rad. Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{P_{II}^2 + (S_{II} + U_{II})^2} = R_{II}$
Thrust Load		T
Total Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{R_{II}^2 + T^2}$

Due to	on Brg. III	on Brg. IV
P	$P \frac{r_2}{c+d} = U_{III}$	$P \frac{r_2}{c+d} = U_{IV} = U_{III}$
S	$S \frac{d}{c+d} = S_{III}$	$S \frac{c}{c+d} = S_{IV}$
T	$T \frac{d}{c+d} = T_{III}$	$T \frac{c}{c+d} = T_{IV}$
Total Rad. Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{T_{IV}^2 + (S_{IV} + U_{IV})^2} = R_{IV}$
Thrust Load		P
Total Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{R_{IV}^2 + P^2}$

Speed Change

$$\text{Gear rpm} = N \times \frac{\text{Number of threads in worm}}{\text{Number of teeth in gear}}$$

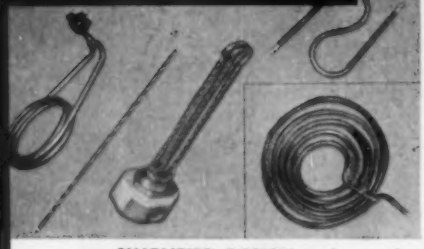
For simplicity in bearing load computations for worm gearing, the normal tooth force E is treated in terms of its three perpendicular elements, namely, P, the tangential driving force at pitch radius of worm; S, the force tending to separate worm from the gear, due to the pressure angle; and T, the thrust produced by the lead or helix angle of the worm.

If you have a problem in the selection or application of worm gearing, De Laval engineers will be glad to put their experience to work for you. Either write us giving complete details, or consult your local De Laval representative. De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, New Jersey

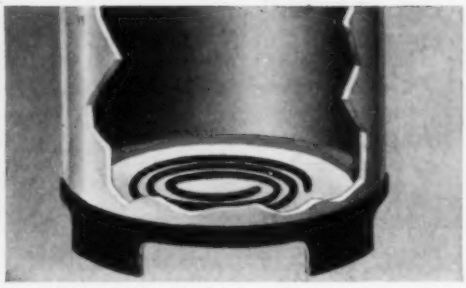
DESIGNING HEAT INTO YOUR PRODUCT?

G-E Heaters Can Be Formed to Your Exact Design; Big Selection Saves You Design and Production Time

HEATING LIQUIDS



1 **SIMPLIFIED DESIGN** and easy installation benefit maker of cement tester, who chose sturdy, flexible G-E tubular heaters.

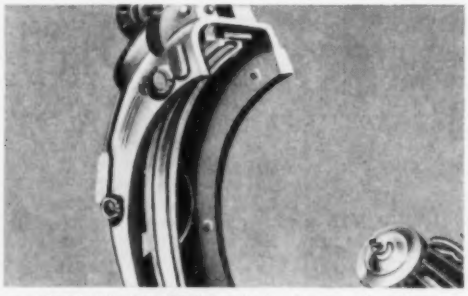


2 **SPACE LIMITATION** is easily overcome with General Electric tubular heaters, which can be formed readily to practically any shape . . . without danger of breaking.

3 **G-E TUBULAR HEATERS** simplify tester use. To begin test, operator need only plug in tester, load specimens, and turn on switch.

HEATING SURFACES

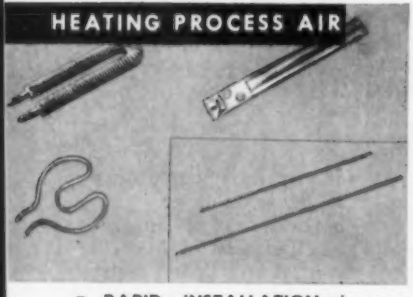
1 **FLEXIBLE BUT RUGGED** G-E tubular heaters are chosen by tire-retreader manufacturer after test. Other makes broke when formed.



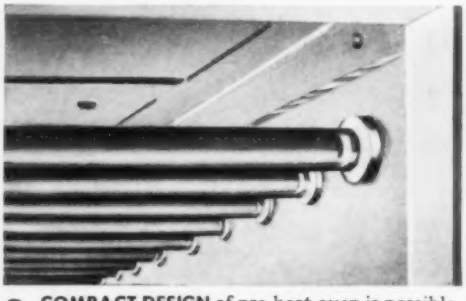
2 **GENERAL ELECTRIC** tubular heaters bend easily to the curved shape of tire retreader. Heaters are inserted into grooves in heating plate to gain maximum heat transfer.

3 **EXACT HEAT** required for top-quality retreading of huge truck tires is achieved with high-efficiency General Electric heaters.

HEATING PROCESS AIR



1 **RAPID INSTALLATION** is one benefit of uncomplicated design. Designer used straight-length tubular heaters in pre-heat oven.



2 **COMPACT DESIGN** of pre-heat oven is possible with inside-mounted General Electric tubular heaters, which replaced outside, top-mounted heaters formerly used.

3 **UNIFORM HEAT** throughout oven combines radiation and convection, since tubular heaters are mounted inside oven chamber itself.

Section F723-9, General Electric Company,
Schenectady 5, N. Y.

Name .....

Company .....

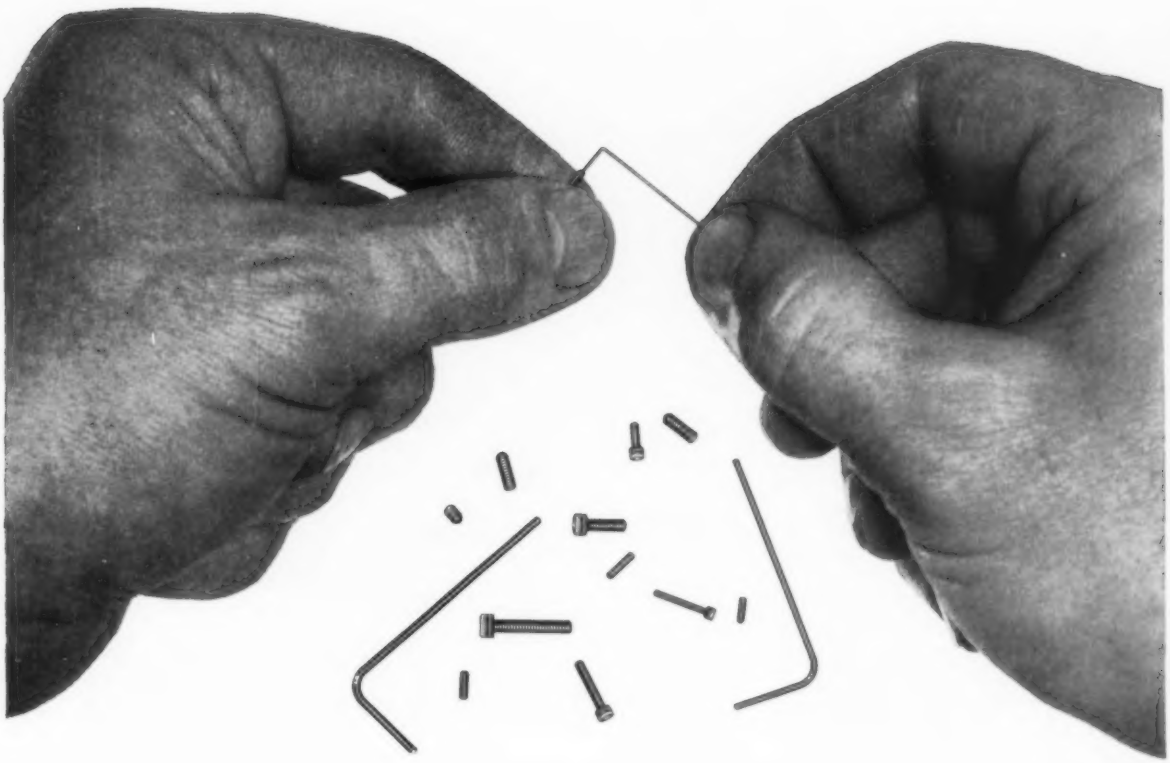
Street .....

City ..... State .....

FREE 1957 CATALOG

60-page Catalog of General Electric heaters and heating devices—describes full line. Also provides helpful application data. GEC-1005

GENERAL ELECTRIC



If you're miniaturizing . . . you'll save space, time and money with Allen Minicaps and Minisets (#0 thru #3 dia.)

These miniature Allen Hex Socket Cap and Set Screws will let you scale down your product sizes even farther. They're made from Allenoy special alloy steel — so strong that you can safely specify fewer screws or smaller sizes.

Allen Minicaps and Minisets are tiny, but very tough! — true Allens, with deep, clean, strong sockets and uniform Class 3A threads. Minicaps have the Allen knurled "Grip-Head" and are trimmed both on top and *under* the head, for tighter fit and better appearance. Minisets have the improved small-cup Allenpoint that drives deeper and holds tighter.

Because sockets are uniformly true hexagon shape, the key or driver fits tight — makes starting much easier, saves a lot of time in assembly.

Diameters of these miniatures run from #0 through #3. Minicap lengths run from ⅛" through ½", and Miniset lengths from 1/16" through ¼". Also standard in stainless steel. Your Industrial Distributor has them now. He'll show you why these Allens — like all Allens — hold tighter and last longer. Or write for information and samples.

Use Minicaps and Minisets wherever you need dependable fastening in very small assemblies:

TV, radio and telephone equipment • Guided missiles, rockets • Panel meters • Electro-mechanical devices and servo-systems • Computers • Control and operating mechanisms for relays • Cameras • Instruments

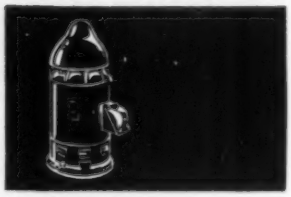
Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.

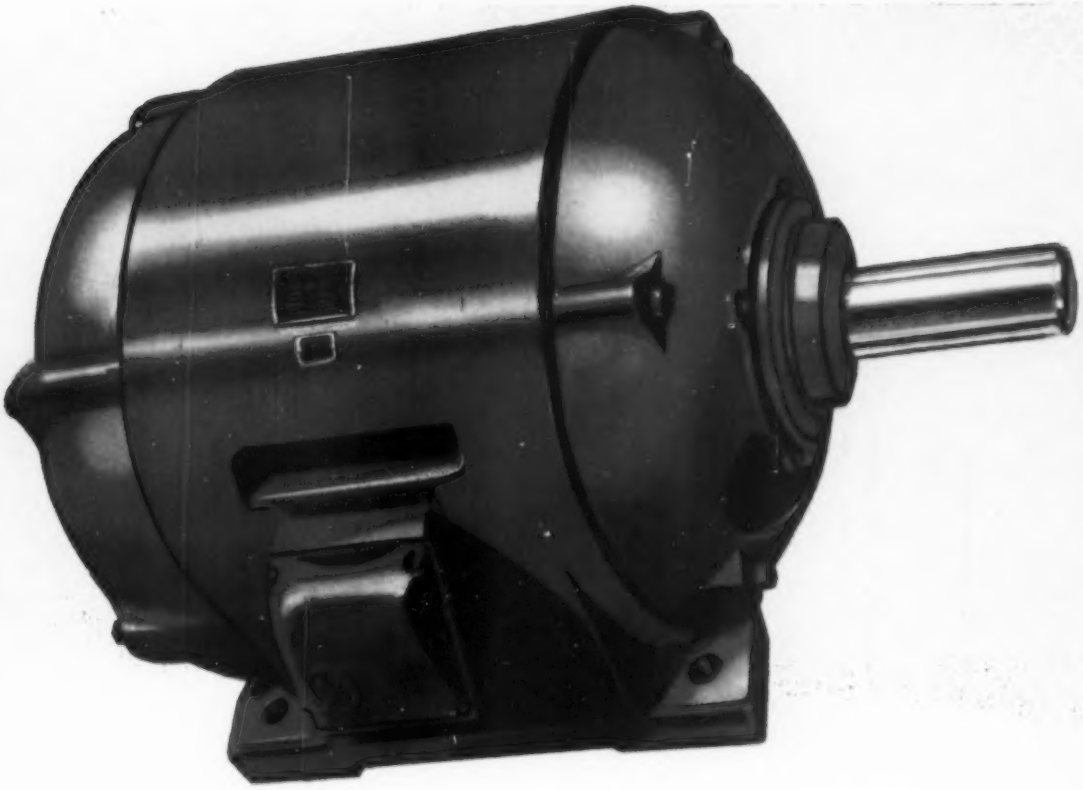
ALLEN HEX-SOCKET SCREWS HEAD

From **A.O.Smith**

NEW DIMENSIONS IN



VERTICAL HOLLOW SHAFT MOTORS
1 thru 150 hp



MOTOR PERFORMANCE

Full-Range . . . Engineered for your requirements

Through research A.O. Smith *. . . a better way*

A.O.Smith

CORPORATION

ELECTRIC MOTOR DIVISION

Tipp City, Ohio

INTERNATIONAL DIVISION: MILWAUKEE 1, WISCONSIN

INTEGRAL HP MOTORS Single phase 1 thru 5 hp; polyphase 1 thru 150 hp

GEAR MOTORS 1 thru 25 hp All reductions

HERMETIC MOTORS 1 thru 100 hp Single and polyphase

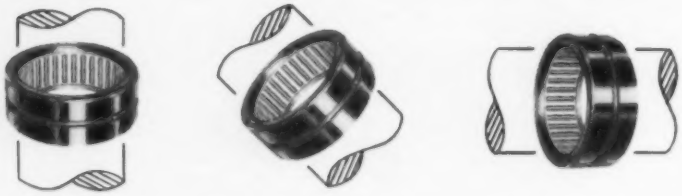
FRACTIONAL HP SIZES Jet pump, and rigid or resilient base motors ⅓ thru 3 hp

GET ALL THE FACTS about the complete line of A. O. Smith motors . . . creative motor engineering services . . . mass-production facilities. Write for new motor Bulletin No. EM 157-B, or refer to Sweet's Product Design File.

ORANGE *Cage Type* NEEDLE BEARINGS

are true running in any position

VERTICAL . . . . TILTED . . . . . HORIZONTAL



Cage assures permanent alignment of rollers

Each needle roller is retained in pockets of a cage made of anti-friction, non-ferrous metal. These pockets guide and align the rollers along their entire length. The cage does not wear on the rollers, since the cage land rides on the outer race. Square end rollers provide maximum effective roller length.

The Rollers Roll evenly — never Skew or Slide

The non-skewing, aligned roller action of Orange Cage Type Needle Bearings adds many additional advantages to the high-load, small-space characteristics of conventional needle bearings.

For example: Less internal friction—quieter running—meet higher precision requirements—operate at higher speeds—may be used on overhung mountings—less affected by misaligned mountings or uneven loading—longer life expectancy.

Orange Cage Type Needle Bearings are available in stock sizes from ½" to 8" dia., interchangeable with all standard needle bearings. Write for Engineering Manual M-56.

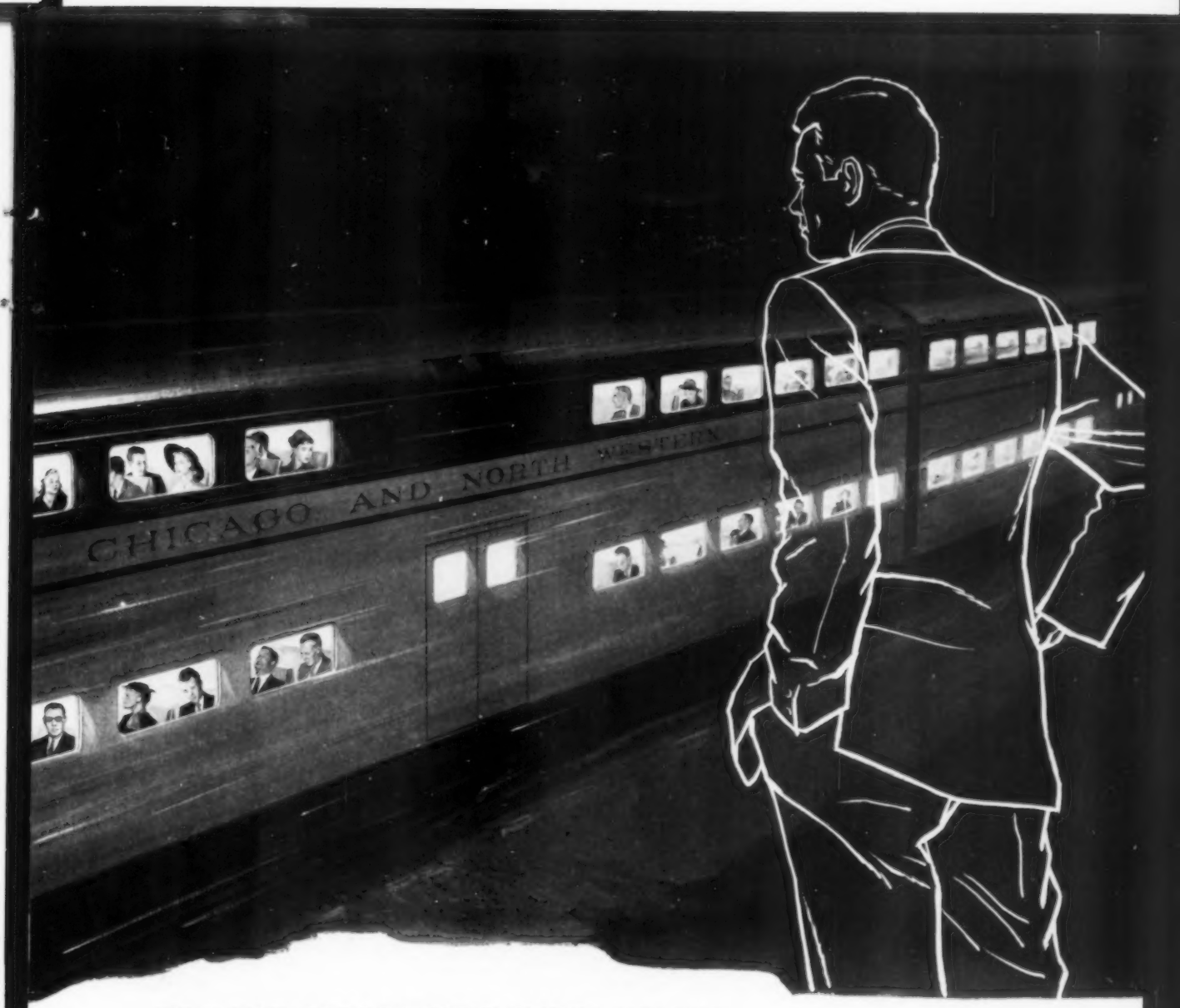
Kingsbury Machine Tool Corp. uses Orange Cage Type Needle Bearings to align the vertical spindles in the drill heads of Kingsbury Indexing Automatics, to meet small space and precision operating requirements.

See the complete line of Orange Roller Bearings at BOOTH 531 Design Engineering Show

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers



HOW THE SILICONES MAN HELPED...

Light up the life of a double-decked commuter

Greater comfort for commuters . . . and increased efficiency for railroads in these double decked coaches now in service on the Chicago and North Western Railroad. Brighter, roomier, air conditioned . . . and passenger capacity more than doubled. Problem? Greatly increased power demand but no more space for motor generating equipment. Solution? Class H insulation with Silicones.

The engineering staffs of Waukesha Motor Company and Harnischfeger Corporation, cooperating with the C&NW, designed and built a Class H generator using UNION CARBIDE Silicones as the insulating resin. Silicones stand up under temperatures and loads that break down other insulating materials. The result is a unit no larger than those previously used, but supplying sufficient power to meet the new demands *plus* any overload condition.

This is another example of how the UNION CARBIDE Silicones Man has helped solve an "impossible" problem. To obtain more information on the many advantages of silicone insulation, a booklet—"Class H Insulation with UNION CARBIDE Silicones" is available by writing to Dept. P-5, Silicones Division, Union Carbide and Carbon Corporation, 30 East 42nd St., New York 17, N. Y.

UNION CARBIDE
Trade-Mark
SILICONES

The term "Union Carbide" is a registered trade-mark of UCC.
In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto.

FENWAL'S THERMOSTATS NOW CIGARETTE SIZE

Some Units Smaller Still

Take Little More Room Than Sugar Lump

ASHLAND, MASS. — If you want to control temperatures in tight spots, you should see Fenwal. Fenwal has cut the size of thermostats way down.

You can fit one of their Midget THERMOSWITCH units anywhere a cigarette will fit. And, if you're working with even less space, one of their Miniature THERMOSWITCH units is what you're looking for. The Miniatures are little bigger than a lump of sugar, and some are even smaller.

The Midgets and Miniatures use the same unique principle used in Fenwal's bigger THERMOSWITCH controls. They use it with the same high degree of success.

The principle of all Differential Expansion THERMOSWITCH units, large or small, is this: a single metal shell expands or contracts with temperature changes, making or breaking totally enclosed electrical contacts.

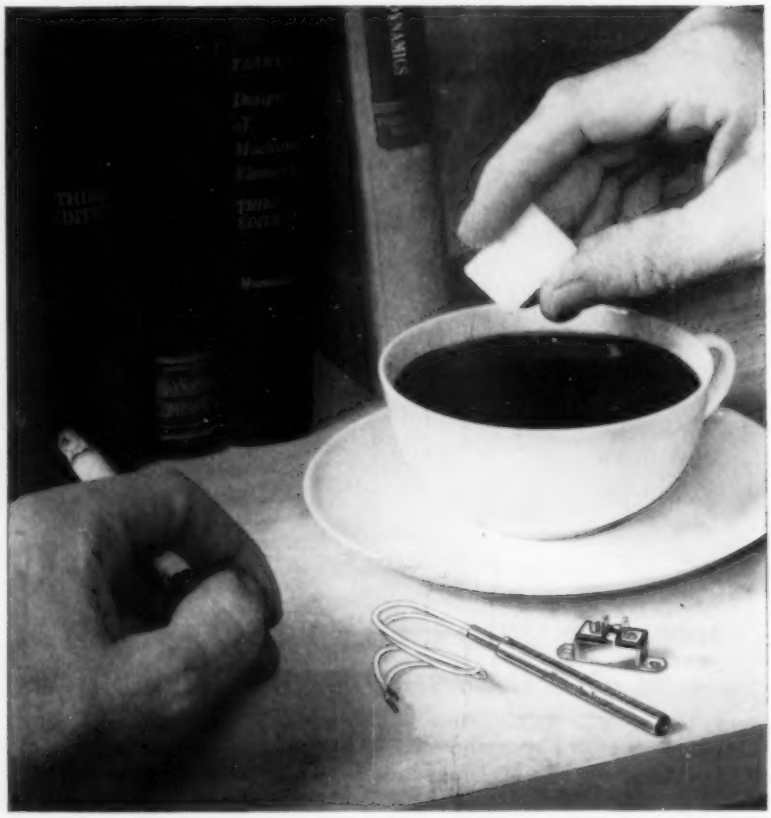
The smallness of the Midget and Miniature units does not deprive them of any of the performance characteristics that have made larger THERMOSWITCH units famous. They have THERMOSWITCH ruggedness, THERMOSWITCH accuracy, and reasonable THERMOSWITCH prices.

Temperature range of the Midget series: −50°F to 500°F. Range of the still smaller Miniature series: −20°F to 275°F.

Midgets and Miniatures, all in stainless steel, come in a variety of mountings. Hermetic sealing is also available.

These Fenwal THERMOSWITCH units are precision-engineered to give optimum temperature control with minimum-sized devices. They remain accurate under the most severe operating conditions.

You should have details on this advance in temperature control at your fingertips. Write for information to **Fenwal Incorporated, 27 Pleasant Street, Ashland, Massachusetts.**



THERMOSTATS FOR TIGHT SPOTS — A Fenwal Midget THERMOSWITCH® unit and a Fenwal Miniature THERMOSWITCH unit — two good answers to the question, "How can you install an accurate, reliable thermostat where there's almost no room?" Actual sizes of these particular models — ¼" x 2 25/32" for the Midget; 1" x ½" for the Miniature.

Fenwal

CONTROLS TEMPERATURE ... PRECISELY

See us at Design Engineering Show, Booth 1414, New York Coliseum

Memo to a Show-bound Engineer

SEE THESE ITEMS IN CLEVELAND-FARVAL BOOTHS 222-224
AT THE DESIGN ENGINEERING SHOW IN NEW YORK'S COLISEUM

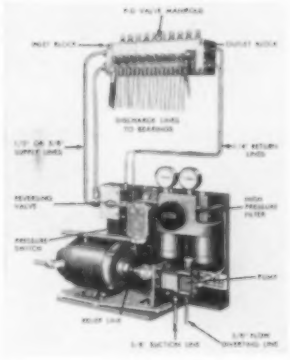
LUBRIVAL — a revolutionary new system to supply and circulate oil

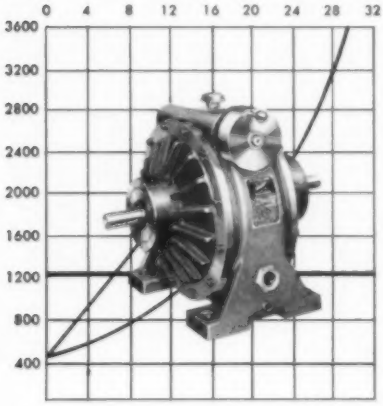
Lubrival is specifically designed for low volume, high pressure circulating lubrication of presses, automatic and semi-automatic machine tools and other machines designed for circulating oil systems.

Lubrival is a Farval system, employing the Dualine principle of delivering oil to measuring valves which pass it under pressure to bearings. Lubricant is force-fed by positive piston displacement. Flow can be regulated over a range of 10 ounces to 1 gallon per minute.

Lubrival Progressive Dualine Valves, manifolded in any number required, have individual sight indicators. A pressure-sensing mechanism warns of clogged or broken lines in *any part* of the system—a feature entirely new to circulating oil systems.

The Farval exhibit at the Design Engineering Show includes a complete Lubrival system in operation, to demonstrate all features of this new method of supplying and circulating oil.





CLEVELAND SPEED VARIATOR

"The drive that's on the ball"

This unique variable speed drive gives you infinitely variable, stepless speeds up to 9:1 (from ⅓ to 3 times input speed). Precise adjustment gives instant, smooth change of output speed by either a hand wheel on the Variator or by manual or automatic remote control. Simple construction, compact, quiet running.

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. No belts, no slippage, no complicated linkage.

Thousands of units now in use on cigarette-making machines, textile machinery, metalworking machinery, pharmaceutical and chemical processing equipment, transfer tables, conveyors and experimental and testing equipment of many types. See production unit and cutaway model in operation in our exhibit.

WORM GEAR SPEED REDUCERS

Sized for every need

For the many advantages of a compact, right-angle drive, you use a worm gear speed reducer—and when you want top quality, complete dependability and long life, you choose a Cleveland. Cleveland manufactures a broad range of varied types and sizes of worm gear drives—speed reducer units and worm-gear sets to be built into driven machines. Most requirements can be met economically with standard units, either "as is" or with adaptations. We also develop special designs for drive units to meet special needs.

You'll see standard models of Cleveland Worm Gear Speed Reducers in smaller sizes at the Show. Our representatives in attendance will be glad to discuss your power transmission problems. Or write us in detail.

FARVAL
CENTRALIZED SYSTEMS OF LUBRICATION

And if you're a stay-at-home—

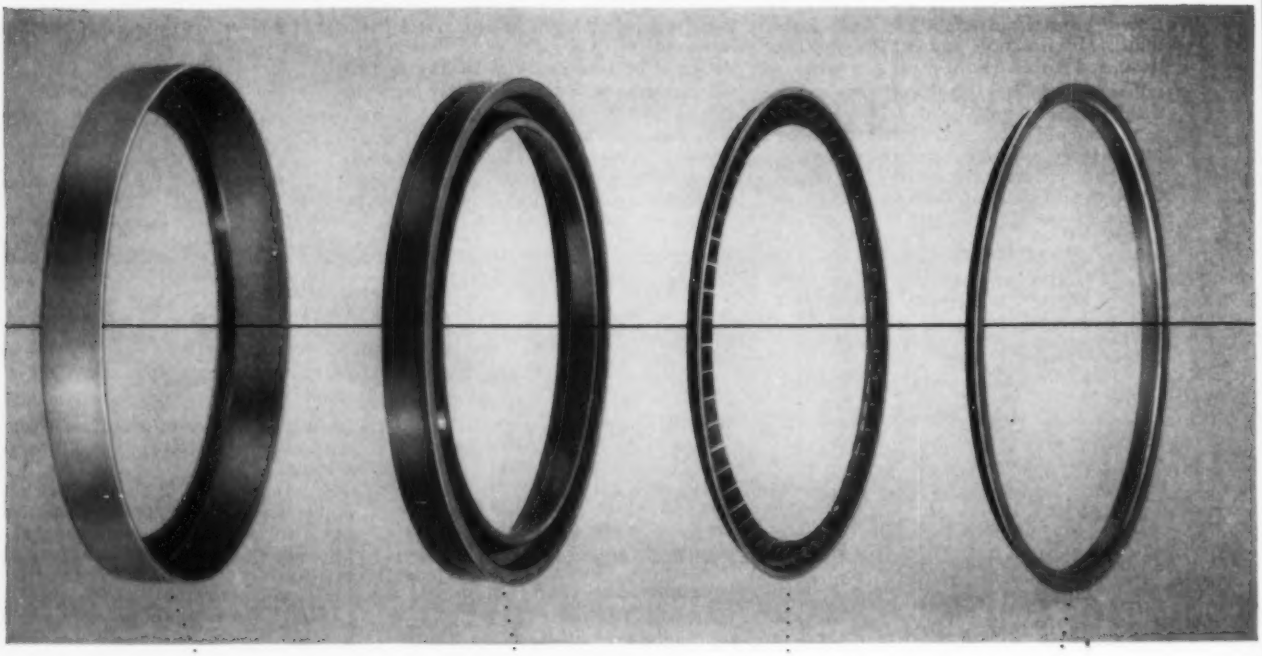
Write for Bulletin 70 which illustrates and describes the new Lubrival circulating oil system, Bulletin K-200 on Cleveland Speed Variators, and/or new Bulletin 145 which shows the complete line of Cleveland Worm Gear Speed Reducers.

THE CLEVELAND WORM & GEAR CO.
3279 East 80th Street • Cleveland 4, Ohio

CLEVELAND
Worm Gear
Speed Reducers

MORE OF THE GARLOCK **2,000**

Put 'em all together . . .



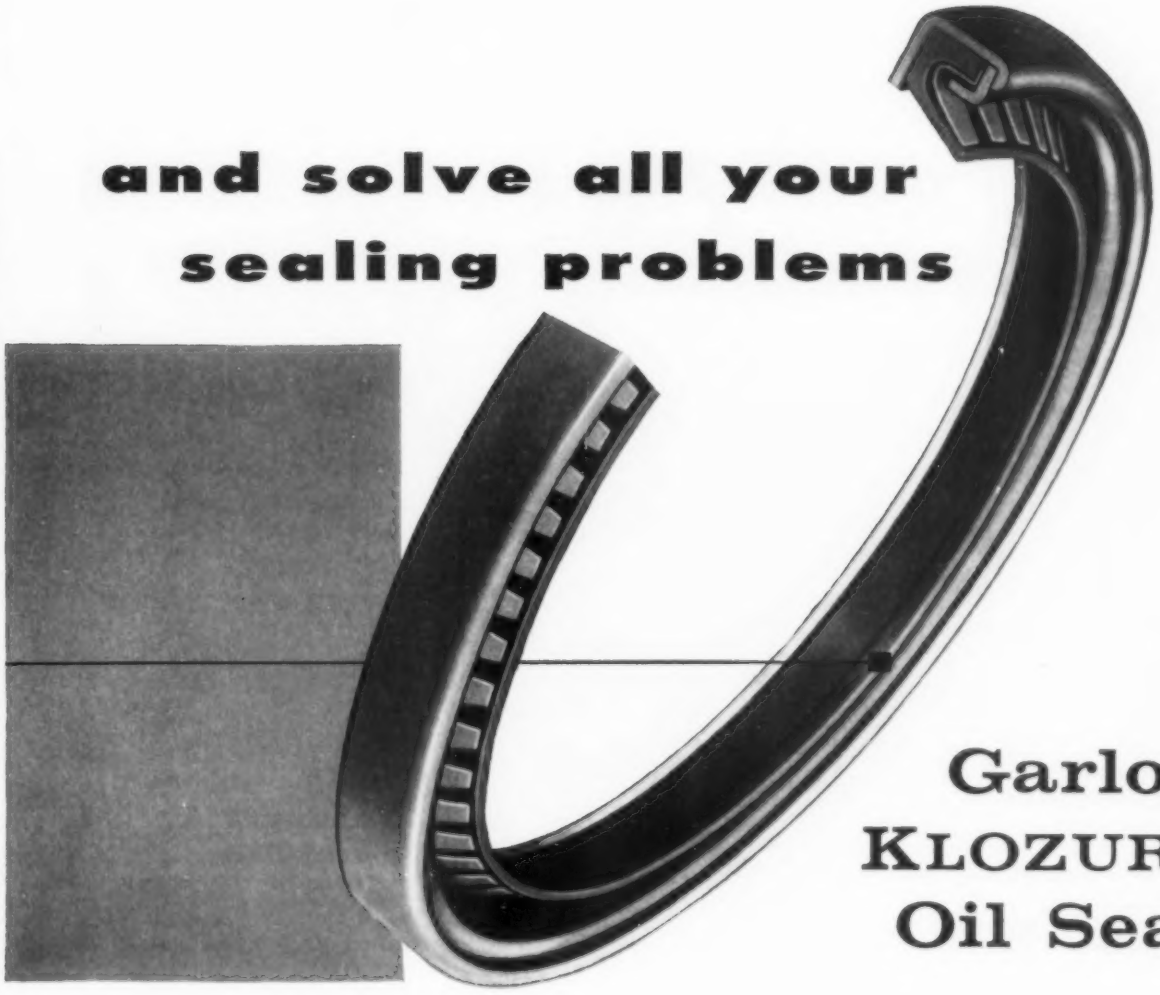
PRECISION FORMED CASE, held to ±.002" dia., has a polished smooth finish . . . no grinding is needed, therefore KLOZURE cases are of uniform thickness throughout, no thick-and-thin areas. Also, the danger of trapping grinding abrasives in the assembly is entirely removed.

THE FINGER SPRING is second only to the sealing element in importance. This one is a distinctive Garlock development which supplements the resiliency of the sealing element in Garlock KLOZURES. It is free to move with the sealing element, and is so precisely tempered that it retains its flexibility throughout the life of the seal. Other conventional springs are also available.

SEALING ELEMENTS in Garlock KLOZURE Oil Seals are made in a variety of shapes from Buna N, Polyacrylate, Silicone Rubber, or Teflon, depending on service conditions. For example, where extreme heat and high speeds are encountered silicone rubber may be desired. Where acids or other chemical conditions exist, Teflon may be desired. In any case, the dependability of the seal is largely determined by the design and construction of the sealing element. Therefore, Garlock offers a wide choice to exactly suit every job.

THE ADAPTER holds and locates properly the sealing element and spring in the metal KLOZURE case.

and solve all your sealing problems



Garlock KLOZURE* Oil Seals

MODEL 53 for larger shafts under normal service

MODEL 71A Springless KLOZURE for excluding dirt or retaining grease

MODEL 63 for normal and high-speed service

Split KLOZURE for installation without disassembly of equipment

Every part of KLOZURE Oil Seals is engineered to give superior service on the job for which it is intended. Through the various combinations of sealing elements, springs, and cases, the proper KLOZURE Oil Seal can be developed for any requirement. Whether your sealing problem involves high shaft speeds or temperatures; corrosive liquids, synthetic fluids, or limited space . . . there is a Garlock KLOZURE Oil Seal to solve it. Why not investigate and see?

Remember KLOZURE Oil Seals are only part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. It's the only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him today, or write for KLOZURE Catalog.

*Registered Trademark

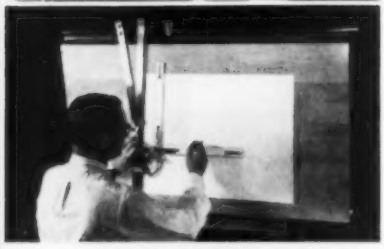
THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

• Track accuracy to .0015"



OPERATES EQUALLY WELL IN ANY POSITION

EMMERT MICRO-DRAFTERS

ACCURACY, SPEED, DURABILITY

. . . all you demand in a precision drafting instrument.

ACCURACY . . . with an EMMERT you can draw—absolutely parallel—horizontal and vertical lines the full length and width of the board with one continuous stroke . . . and—absolutely parallel—lines at any angle the length of the scales. . . . No other drafting instrument can match this precision.

SPEED . . . an EMMERT operates with finger-tip control, changing position to any area of the board, accurately in seconds. There are no blind spots

DURABILITY . . . EMMERT'S stainless steel construction, absolute minimum of wear points and moving parts assures unlimited use and operation before requiring service.

MICROMATIC QUADRANT

Here, precision is accomplished by an amazingly simple design. Accuracy of all angles from 0° to 360° and adjustment to 2½ minutes is assured by fine precision tooling. Full visibility at all times and clear sharp calibrations eliminate eye-strain. The entire counter-balanced unit travels the full length of the vertical blade evenly and smoothly with just-rite pressure. Just a slight thumb pressure releases the worm gear permitting the desired amount of movement. Finer settings are made by the handy worm screw. These features with their positive "can't slip" action, provides speed and ease of operation unequaled in any other instrument.

• EMMERT builds many desk and board units to be used in conjunction with the Micro-Drafter—write direct for additional information and prices.

EMMERT MFG. CO.
800 N. MAIN STREET
WAYNESBORO, PA.

Gentlemen:

Please send me the complete EMMERT Story.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

EMMERT

DRAWS THE ACCURATE LINE

EMMERT MANUFACTURING COMPANY
WAYNESBORO • PENNSYLVANIA

MANUFACTURERS OF PRECISION DRAFTING INSTRUMENTS AND EQUIPMENT

PERSPECTIVES

in design and development . . .

Engineering Student Mortality Rate

If all the college freshmen who start out as engineers were to graduate as engineers four year later, the present shortage in that field soon would disappear. But such is not the case. As an example of how many of these students fall by the wayside, compare the total U. S. freshman class of 1954-55 with the sophomore class of 1955-56. Exactly 72,825 engineering students were enrolled as freshmen, while the following year only 55,767 remained to enroll as sophomores. The average attrition rate in the first year is about 24%. This attrition goes on for each of the four years—at a decreasing rate, of course—until 57%, the present estimate by the U. S. Office of Education, drop out.

In engineering schools across the country, the attrition rate will run as low as 25% and as high as 75%. Fifty-seven per cent attrition is high, to be sure, and engineering is always accused of being the pacesetter. But, this "failure" figure is no higher than that of the other disciplines. Furthermore, while 57% of the engineering students are lost to engineering, they are not lost to higher education. Starting at the top of the educational scale, they can switch to a less rigorous curriculum when the going gets rough. Those starting in a less difficult field are usually lost to higher education for good when they flunk out.

In addition, as one Dean of Engineering pointed out, "The attrition rate in engineering school is not as high as it is in industry. Many engineering students, by the time they are seniors, have made plans concerning their future after graduation, and it does not include engineering."

Why . . .

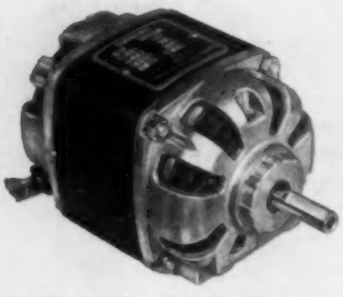
In questioning the Deans of engineering schools on the status of student attrition, *Product Engineering* learned that the problem is about the same as it was in 1938-39. After World War II, the rate dropped slightly with the first few classes, which was attributed to the maturity and determination of the veteran to get an education. Since then the attrition rate has returned to approximately its 1939 status. However, at one of the large Midwestern state schools, the comment was made that attrition figures during the "veterans' bulge" should be looked upon with care because the standards dropped markedly at that time.

Poor Preparation In High School

Why did the students leave engineering? The reasons go something like this: To a man the various Deans of Engineering questioned said that the main reason was poor preparation of the student at the high school level. One Dean said this: "An 80% high school average used to be good enough to consider a student good college material. Now an average of 85-90% is required. High schools purposely jack up the grades to make them look good because they are only interested in getting the student into college. The schools consider this their prime function. Trial college board examinations are given two and three times to the high school student, so that on the last one—the one that counts—he gets a high score. Because this test, plus the student's over-all high school average, and a recommendation by the student's counselor are weighed heavily by college officials, the student is usually accepted. Then he learns that he has to work, and it comes as quite a shock.

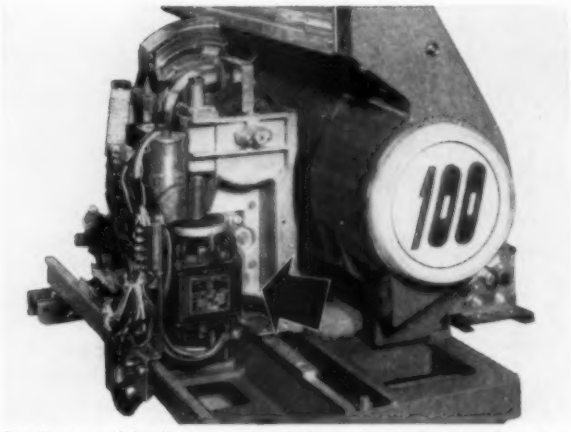
(Continued on page 125)

Seeburg Select-O-Matic uses BODINE MOTORS because..."THEY RUN QUIETLY, PROVIDE UNINTERRUPTED SERVICE"



Bodine Type K-4 motor

This small powerful Bodine induction motor drives the record changing mechanism and turntable of the Seeburg 100 and 200 Select-O-Matic phonographs. Compact size (height and width 2⅞"), constant speed, quiet operation, no radio interference, light weight and 5 mounting arrangements make the K-4 particularly well suited for use in office machines, movie projectors, communication equipment.



Inside view of the Seeburg record changing mechanism showing the vertically mounted Bodine Type KCI-42 motor. The 1/100 HP, 1600 rpm induction motor used in the Select-O-Matic positions the carriage, extracts the record from the magazine, plays it, and then replaces it. This sleeve bearing Bodine motor operates so quietly that no vibration is transmitted to the pickup head.

Here's a typical Bodine-motor-powered Seeburg automatic phonograph. It's coin operated and permits the selection of either side of 100 records. A dual credit system enables separate pay rates to apply to the standard records and the extended play records. Seeburg automatic phonographs have successfully withstood life tests of over one million selections.

Mr. M. W. Kenney, Director of Engineering, J. P. Seeburg, a Division of Fort Pitt Industries, Inc., tells why his organization uses Bodine Motors . . .

"The Select-O-Matic mechanism requires a motor that is quiet in operation and free from vibration; it must have high starting torque, fast reversal characteristics, uniform speed-versus-voltage, and very low stray magnetic field. In addition, the motor must give many years of uninterrupted service in the field. Bodine motors have satisfied all of these requirements for many years."

Be sure your motor is as good as your product. For information contact Bodine Electric Company, 2260 West Ohio St., Chicago 12, Ill.

BODINE
fractional / horsepower
MOTORS
...the power behind the leading products

Bodine manufactures fractional horsepower electric motors for:

adding machines, letter openers, sanders, vending machines, exhaust fans, duplicating machines, hand dryers, portable tools, sound recorders, air conditioners, check protectors, respirators, voltage regulators, X-ray timers, traffic signal timers, stirrers, calculating machines, envelope sealers, and for many other applications.

"Many of them think that college is nothing more than the 5th year of high school. Take the student who had an 86% high school average, and flunked out after his first year. He said that he didn't have to work in high school to get that average. In college he was overwhelmed. Our incoming freshman class of over 400 students has had over the past four years an increasingly higher secondary school average. However, these same groups on the following June have showed a steady increase in the number of men whose freshman average was below a "C," and who were consequently on probation. This, perhaps, is the end result of a high school education which does not pose a challenge. It develops poor work habits, mainly an unwillingness to do hard work. Another factor related to this problem is the difficulty the high schools have in getting even mediocre teachers in science and mathematics because of low teaching salaries and the lure of industrial jobs."

Students Lose Interest

Many students don't flunk out of engineering. They lose interest. This, undoubtedly, is the second major contributing factor to the high attrition rate. Many students find out that engineering is not what they thought it was, because in the first two years there is little engineering and a lot of background. The glamour of the "be an engineer" advertisements neglected to mention the hard work involved. At one college the comment was made that last year's freshman class showed definite signs of an "overselling" of engineering, and that there is a danger here. Then there are the parents who have never seen $450-470 a month, not to mention that this will be a starting wage upon graduation from college. So they urge their sons to study engineering. Glamour of the end product has lured too many into engineering, with disastrous results.

Financial problems cause some dropouts, but this is being reduced by an increase in scholarship funds for students who need them.

Colleges Clamp Down

Entrance requirements are being increased and new methods of screening students are being tried by the colleges. Many use psychological aptitude testing methods. In some cases the tests have a definite bearing on the student's original choice of curriculum, but some colleges use them mainly as a tool for counseling and guidance through the student's college career. Stanford University is experimenting with supplementary tests beyond its regular college entrance exams. Last year's freshmen were given achievement tests in one or two fields of their choice, and university officials are looking over the results to see if they would have done a better job of student selection if the applicants had taken the tests before they were admitted.

California Institute of Technology does not use psychological testing methods, preferring instead the results of the college board examination, high school records, personal interviews with the applicants at their high schools, and concurrent discussion with high school teachers and counselors. Cal Tech frankly admits that it "goes through a great deal of agony" to select its freshmen students.

Case Institute of Technology does not use psychological testing, but has careful screening methods on intelligence, background, and achievement. Dean Karl B. McEachron says, "There is no way to test 'motivation', which is the most important factor in determining if a man stays in college."

Colleges can afford to be selective. Many get applications for four to five times as many students as they can accommodate. Of course,

(Continued on page 127)

COST

IS A BIGGER WORD THAN EVER

RINGS ROLLED & FLASH-WELDED from a Mill-Rolled Section

SAVED $220.63 EACH

A ring originally designed as a casting weighed 390 lbs. and cost $280.00. Later it was purchased from Amweld, as a rolled and flash-welded ring made from a contoured mill-rolled shape. More than triple savings resulted. Basic cost dropped to $59.37 and weight was reduced to 94.5 lbs. In addition, considerable time and money were saved in the finished machining operation.

Switching to Flash Butt-Welding of Mill-Rolled Sections Slashed Production Cost 76½%

SAVED $103.46 PER RING

Rough rings purchased by a well-known manufacturer of jet aircraft engines weighed 135 lbs. each. Most of this weight was excess metal which had to be machined away. American Welding's Industrial Products Division, working with this company, studied the product and recommended a flash butt-welded ring, formed from a special mill-rolled shape. Adopting this new ring saved 88 lbs. of metal and eliminated much of the machining time required.

American Welding can help cut costs in your plant by suggesting the use of rings rolled and flash welded from mill-rolled or extruded shapes.

THE AMERICAN WELDING & MANUFACTURING CO.
140 Dietz Road • Warren, Ohio

Contact the Industrial Products Division of The American Welding & Manufacturing Company. We will be glad to show you more actual cases of cost savings.

AMERICAN WELDING
The World's Leading Manufacturer of Welded Rings

many of these fall in the "multiple" application class. That is, students who send out applications to eight or ten colleges to improve their chances of being accepted by one in case the college of their first choice turns them down.

No Room

Most of the colleges are booked to capacity because they have long since realized that in order to end up with a full class, it is necessary to accept more students for enrollment than they can accommodate. Final registration runs about 80% of the number of students who have been issued permits to enter. Most schools admit that this is a statistical gamble that they must take each year.

To discourage "jumping around" some colleges are putting fees on registration. Fenn College in Cleveland, Ohio, charged only $5, but said that it helped. The University of Southern California, School of Engineering, levied an entry fee of $25 which is not refundable, but which is applied toward tuition for the semester for which the student is applying. Case Institute of Technology says that it keeps in such close contact during the summer with the men it has accepted for the freshmen class that it can usually tell within one per cent how many will be in class. The system failed one college last year when it made the customary allowance for "no-shows." It didn't hold up, and the school was inundated with students it was morally obligated to accept, even though it meant packing them to the rafters.

Five Year Course

A question often raised is the five year program for engineering students. This program takes two forms. One has the engineering and liberal arts courses sprinkled out over the five year span, with perhaps the liberal arts getting the benefit of the extra year. "This is what it was supposed to do," says one Dean who is against the program, "but the schools that have it are using the extra year to slip in more engineering courses." The second five year plan is what is called a "3 and 2." The first three years are devoted to liberal arts and the usual first and second year engineering preparatory courses, while the last two years are spent on the student's major field. After five years he graduates with a B.S. and a B.A.

For and Against

Ohio State University has had the five year program for ten years, says that it has been successful, and that the faculty is very happy with the program. Also, on a recent poll of the alumni, 78% said that they would send their sons to a five year program, and 81% said that the program should be continued. Dean Carson says, "The student is far more mature in his fifth year than the mere age change would indicate. As a result, he learns much more in those courses requiring mature judgment than does his younger counterpart. The obvious disadvantage today is that since a student can get the same degree in a four year program elsewhere, we are handicapped in attempting to sell the five year program. Quality is nebulous to a young man. A degree is tangible."

Rutgers University has an optional integrated five year plan leading to a B.A. and a B.S. but says that, "We have not had too many takers."

Other opinions varied on the 5-year plan. Several Heads of Engineering Schools are against it saying that a four year course is sufficient time to give a student a good course in basics. "Don't teach the boy current practice. Give him sound principles on which he can build. The curriculum should be pruned every year or two to keep it tight. Five

(Continued on page 129)

FAST FASTENERS FOR FASTER PRODUCTION

With the race on for better products at lower costs, production men everywhere are turning to time and labor saving devices of all types. Eaton-Reliance Keps will fasten assemblies in a minimum of time with a maximum of efficiency.

The tooth type washer preassembled, freely rotating on the nut, permits a quicker assembling of the part, time savings, increased production, an elimination of lost parts, and exactly balanced inventories. They are made to "funnel" onto the bolt providing easy starts.

Keps can be hopper fed thus providing the additional advantage of automatic assembly. Investigate this new efficient fastening device and profit by these savings as hundreds of other quality product manufacturers are now doing.

Additional information supplied upon request or a Fastening Engineer will call without obligation.

EATON — RELIANCE DIVISION
MANUFACTURING COMPANY
514 CHARLES AVENUE • MASSILLON, OHIO

SALES OFFICES: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

years could be spent to greater advantage by taking a B.S. in four and a Masters in the fifth."

Dr. F. C. Lindvall, of Cal Tech, is against the five year program, preferring the extra time for a Masters degree. "But," he said, "even at the present time it takes most engineering students more than just the four years to complete the work for a B.S. Four and one-half years is more the typical period. Many students use this extra time to take advanced engineering work, or more work in the humanities."

George T. Harness, Associate Dean of the University of Southern California, School of Engineering, says that "Unquestionably, engineering courses should be longer than the present four years. Probably the ideal would be a six year program involving two years of pre-engineering, followed by a four year professional engineering course."

State Schools Must Take All

Some state universities and land-grant schools have a problem. By law they are forced to accept all high school graduates, consequently the admission standards are low. And it follows that the schools with the lowest admission standards have the highest attrition rate—65% or better. As several Deans of private colleges stated, "It is my impression that the Deans of publically supported schools would like to raise the standards, but they are prevented by law or politics from doing so."

These colleges, therefore, must operate on the policy of: "We have to take them, but we don't have to keep them." The first year, then, is devoted to nothing more than a mass housecleaning. However, because of the increasing number of applicants, one state school, Illinois, is restricting students who were in the lower quarter of their high school class. This may be a trend. Another state school has within its organization a General College, which is a first class "screening" department. As the state school is forced to accept all high school graduates, all students enter the General College for the first year. By the second year, sufficient screening of the students gives the authorities some insight into the student's capabilities, and where he should go. Poor risks as engineering students are kept out at this point.

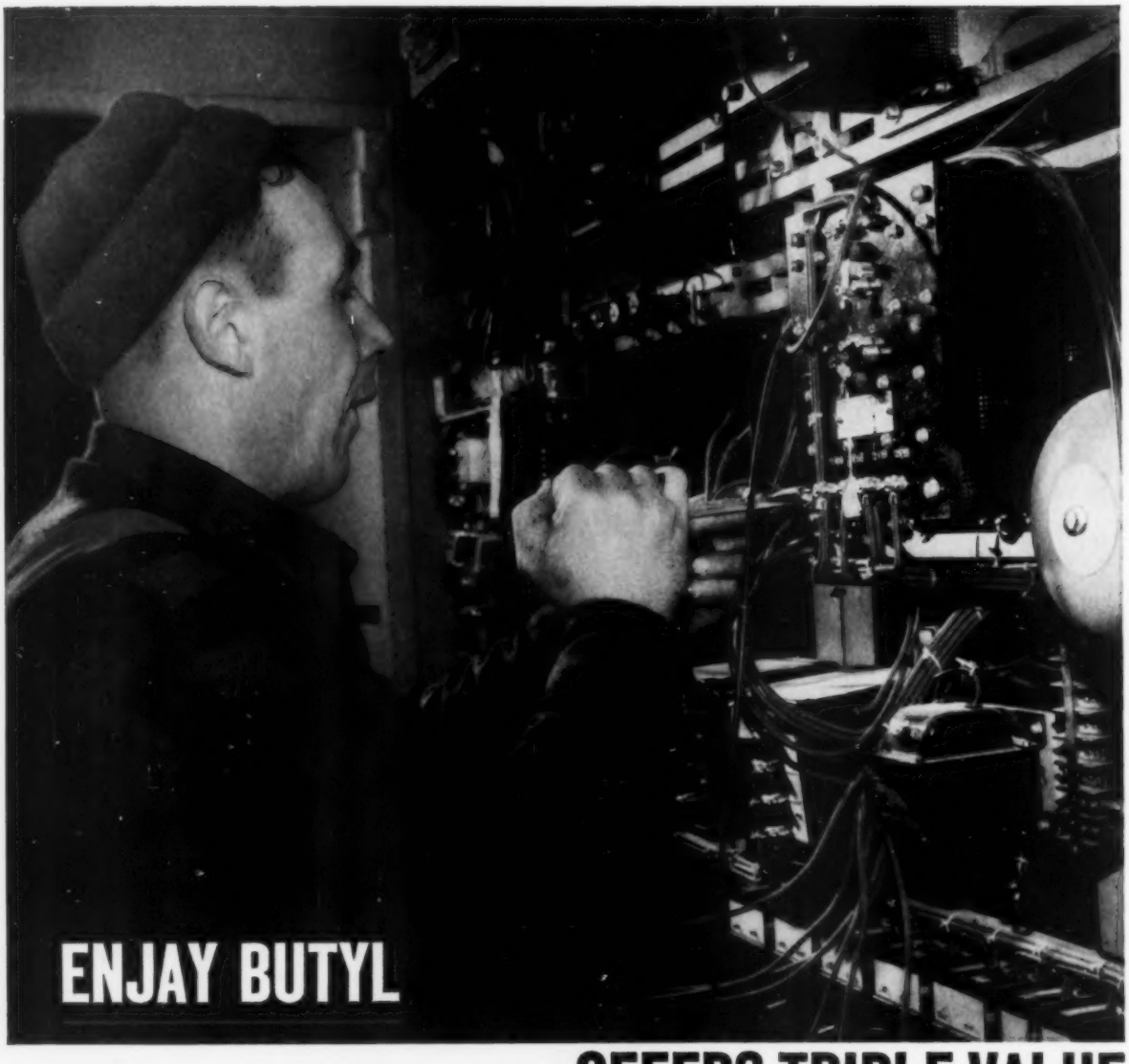
In California, the state universities are not under pressure to admit all comers. California has hundreds of junior colleges which act as a sifting ground, and these students can take either vocational courses or college preparatory courses. Good junior college students can transfer to state colleges or universities. The courses are numbered the same as the university courses, so transferring poses no difficulty.

From A Small School

In the Middle West, there is more of a tradition for public education with state schools than anyplace else. Any high school graduate is admitted because it is believed that a person should be given a chance to show what he can do. For example, the average high school in Kansas has 75 students, and it is not expected that the students have had good math courses because of the lack of competent teachers. But provisions are made in the state university for the student to take non-credit courses in the subjects he could not take in high school, and by the second term he is ready to start his college curriculum. Usually a student from a small high school does not do too well in the first year of college, but he picks up after that. It all indicates the lengths to which some state schools go to salvage a student.

Although such land grant colleges have only 20% of the country's total

(Continued on page 131)



electrical wonder rubber OFFERS TRIPLE VALUE

Performance! Versatility! Economy! In all three, Enjay Butyl is the world's outstanding rubber value. In a wide variety of applications, Enjay Butyl rubber stands *unmatched* in its ability to resist ozone and corona, impact and abrasion, moisture and weathering . . . properties that contribute to the *outstanding* performance of Butyl-made products.

Instrument transformers, underground service cables, high voltage industrial cables . . . in these, and many other electrical applications, Enjay Butyl out-performs and out-lasts *all other* types of rubber, synthetic *or* natural. *Low-in-cost* and *immediately available*, this truly wonder rubber may well be able to cut costs and improve performance in *your* products. For further information, and for expert technical assistance, contact the Enjay Company.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa

ENJAY BUTYL

Enjay Butyl is the greatest rubber value in the world . . . the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

enrollment of college students, these schools turn out 40% of the engineers at the undergraduate level. Over 50% of all the Doctorates in Sciences are given by these colleges.

Graduation rates differ geographically, according to a study made for the U. S. Coast Guard by the Educational Testing Service, Princeton, N. J. The study was made in 1953 of over 13,000 fall-of-1948 freshman entrants to 101 engineering colleges. It showed that in the South Central States (Arkansas, Louisiana, New Mexico, Oklahoma, Texas) less than one-fifth (18%) of the entrants graduated in four years, while about one-half (47%) of the entrants in the Northeast states (the New England states plus New York, except Metropolitan New York) graduated.

Difficult Courses

Nemesis courses of engineering students are mathematics, physics, and chemistry. Dr. Harness of the University of Southern California added one more subject to his list—English.

Math, physics and chemistry take the biggest toll of those who flunk out, because they are the most important in the engineering curriculum, and because preparation is the poorest. Good high school teachers in these fields are hard to find. Parents don't encourage their offspring, passing off poor grades with, "Oh well, I wasn't good at math either."

Engineering and Arts

Still another problem exists in the large universities where engineering students must take their mathematics, chemistry and humanities courses from instructors in other schools of the university. In a report of the Humanistic-Social Research project, published in 1956, by the American Society for Engineering Education, it was pointed out that: "It is not accidental that humanistic-social programs seem to be more highly developed in the independent technical schools than elsewhere. The essential reason is that in such institutions the engineering and arts faculties are more closely identified, and the departmental structure of the humanities is less strong than in the large university system.

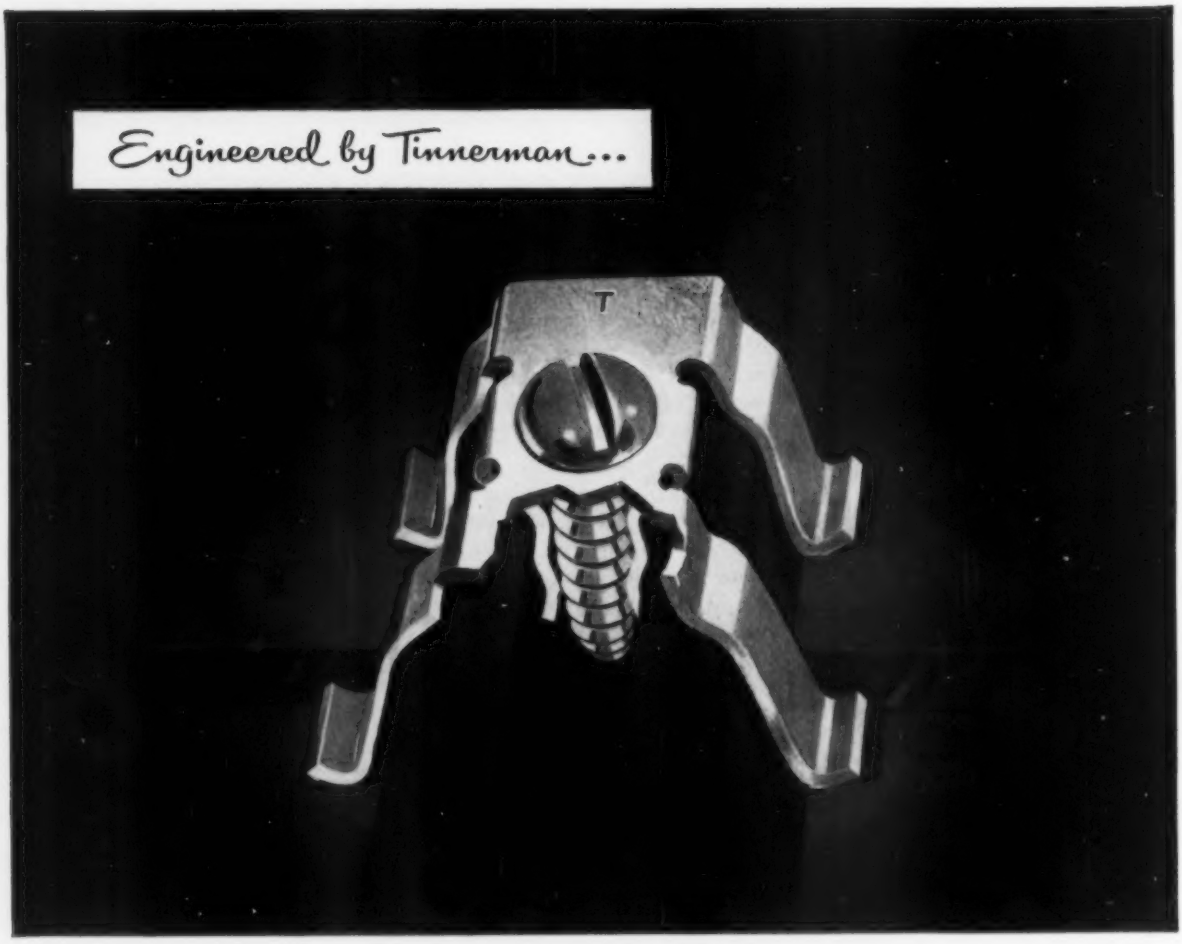
With the large universities, that committee found that both faculty units to be considered (Engineering and Arts) had to discuss the problems early in order for success to be achieved. One Dean of Engineering said, "Engineering schools should have better coordination between the mathematics, chemistry and English departments in the other schools within the university.

Case for Technicians

Obviously, many of the engineering students who fail in their first or second year, would make good engineering technicians, for which there is a great demand today. As Gordon Carson, Dean of Ohio State University College of Engineering, said, "I think that it is quite possible that many of the students who apply for admission to colleges of engineering are really technicians at heart. For these boys it would be far better to steer them into a technical institute of high quality immediately, rather than permit them to become failures in a college of engineering."

Improved screening is a good line of approach. But along with this should go a good public relations campaign to build up the importance of engineering technicians and engineering aides. Dean Frederick E. Terman, of Stanford University, agrees. He says, "I suspect that it would be difficult to get people who have planned to be engineers to go into technician training voluntarily. They may fail their engineering courses, and end up as technicians, but they don't want to admit at the outset that it will happen."

—PAUL ANDERSON



6-fingered **SPEED CLIP**®
holds glass panels tight, saves 46%!

This special SPEED CLIP fastens glass panels to aluminum extrusions with a grip that prevents slippage. Heat stays in, rain stays out of greenhouses and similar glass structures. Working closely with engineers of the Metropolitan Greenhouse Mfg. Corp., Brooklyn, Tinnerman developed this unique fastener that saves almost one-half the cost of former less effective assembly methods!

Installation is fast and simple. Two overlapping glass panels are positioned against the extrusion. A screw driven into the spring-steel SPEED CLIP spreads the two center fingers outward to grip the inner walls of the extrusion. No secondary fastening devices required—SPEED CLIPS hold tight, yet are easily removed to permit replacement of glass.

This is another example of a fastener engineered by Tinnerman to satisfy special, complicated fastening problems. A Fastening Analysis of your products may produce a similar cost-cutting solution. See your Tinnerman representative soon.

TINNERMAN PRODUCTS, INC.
BOX 6688 • DEPT. 12 • CLEVELAND 1, OHIO

TINNERMAN

Speed Nuts®

FASTEST THING IN FASTENINGS®

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. Great Britain: Simmonds Aerocessories, Limited, Treforest, Wales. France: Simmonds, S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). Germany: Hans Sicklinger GmbH "MECANO", Lampa-I-Ll.

DESIGN BY COMMITTEE—

Crutch or Opportunity?

COMMITTEE—
A group of men who keep minutes and waste hours.
—Anonymous

COMMITTEE—
A group which succeeds in getting something done only when it consists of three members, one of whom happens to be sick and another absent.
—H. W. Van Loon

If Moses had been a committee, the Israelites would still be in Egypt.
—J. B. Hughes

A committee is a group of men who individually can do nothing, but collectively can meet and decide that nothing can be done . . . If you want to kill any idea in the world today, get a committee working on it . . . Lindbergh's solo flight across the Atlantic was not *a miracle, but it would have been had it been done by a committee.*
—C. F. Kettering

Leaders, particularly those with genius, have always resented the committee—witness the accompanying quotations. Yet this age will undoubtedly go down in history (if there is anyone left to write it) as the Age of the Committee. Why this seeming paradox?

When we were gathering material for the following 24 pages, we found that design today is also controlled by committee. (The word "committee" is frequently avoided—"task force" or "group" is used instead.) So we formed our own committee to see why such committees are necessary. Here are the major factors, in our opinion:

1. Early design was empirical; modern design is scientific. Intuition, perfected by cut-and-try, is being replaced by the planned approach to development of a needed product, using contributions from a variety of specialists.

2. Modern products involve complexity beyond the capacity of an individual, no matter how competent. Special problems in materials and production techniques demand specialists. We recall the sudden rise of "appearance design" twenty years ago; today it's plastic housings, adhesives as fastenings, and like problems that call for consultants.

3. Redesign is usually concerned with squeezing labor out of a product. It thus demands assistance from those who know most about the labor that goes in—namely production men.

4. Market potentials, needs and changes are a basic factor in redesign, except in highly engineered or specialty products. Appearance and accessories often have much to do with saleability but little to do with functional design. Such factors demand assistance from sales executives.

Couple these situations with purchasing, ordering and inventory variations, tooling differences, inspection standards—and the committee is born. Judging from succeeding pages, it has been most effective—an opportunity rather than a crutch.

L. T. Faugeman

FACTS

about

NEW DEPARTURE BALL BEARINGS

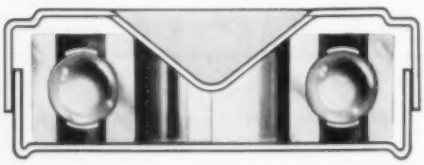
Transparent box permits quick visual inspection of contents. Box sealed with oil-resistant tape—can be resealed after opening. Bearing identification clearly marked on outside of box. Bearings kept free of contaminants right to assembly area.

PROTECTION FOR PRECISION

No precision machine is better than the bearings that support its rotating parts. That is why you find so many highly accurate machines employing New Departure precision ball bearings of ABEC 5, 7 and New Departure 9 specifications.

But, to be sure that all the fine performance of which these bearings are capable is fully obtained in the machine, such bearings must be protected from dirt, needless handling and exposure before mounting.

Now New Departure gives you such *protection* for *precision* in another "new departure"—a sealed, transparent container with the important advantages described at the right. Available for a wide range of ABEC 5, 7 and ND 9 specification bearings.



Inverted cone in cover holds bearing in central position—permits packaging several sizes of bearings in one box size.

Easy to stack and stock. Box tops and bottoms mate for quick, non-sliding stacking—with identification markings visible for each box.

VISIT NEW DEPARTURE • SPACE 1240
DESIGN ENGINEERING SHOW
NEW YORK CITY COLISEUM, MAY 20-23

SEE "WIDE WIDE WORLD" SUNDAYS—NBC-TV

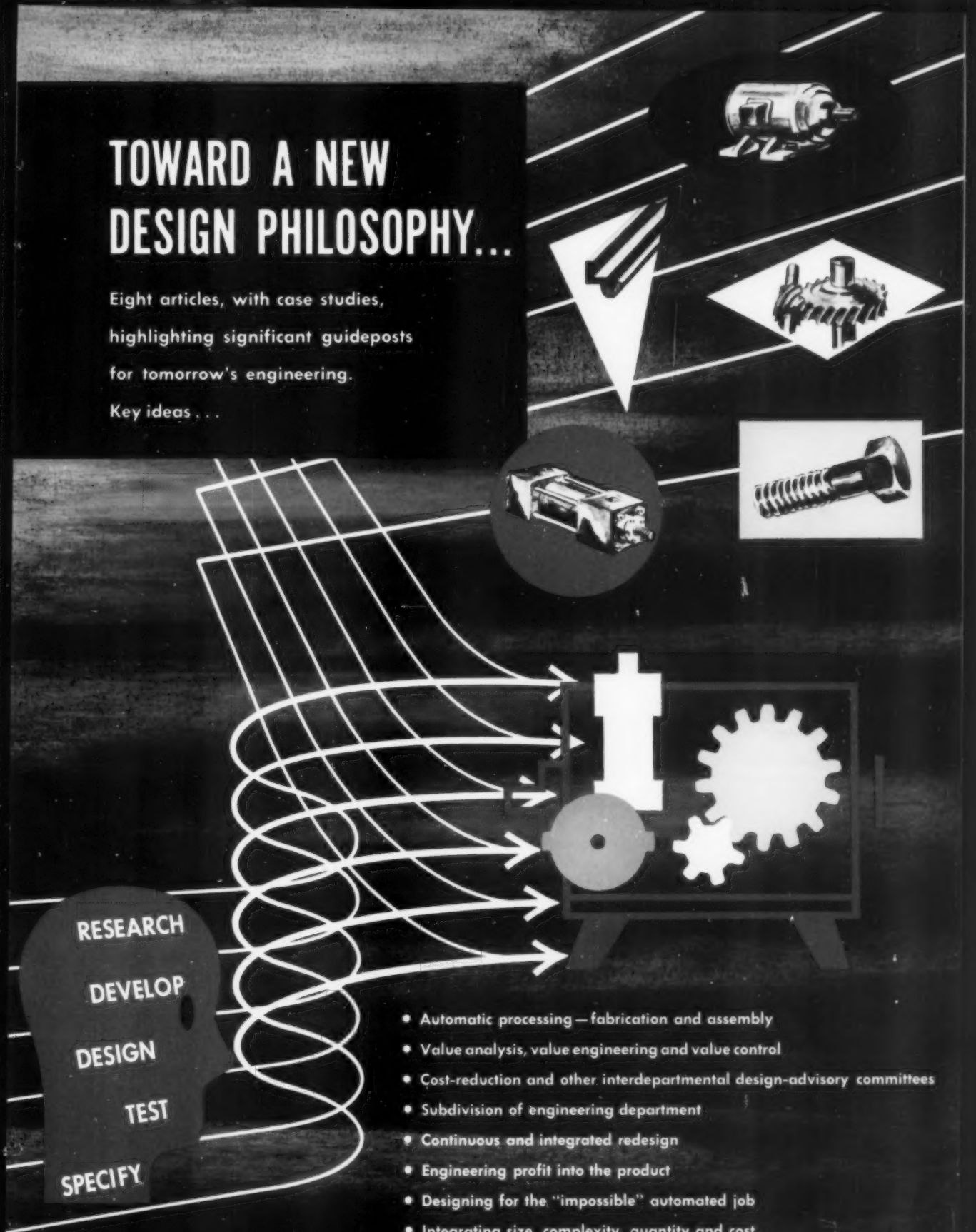
BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

TOWARD A NEW DESIGN PHILOSOPHY...

Eight articles, with case studies, highlighting significant guideposts for tomorrow's engineering.

Key ideas . . .



- Automatic processing—fabrication and assembly
- Value analysis, value engineering and value control
- Cost-reduction and other interdepartmental design-advisory committees
- Subdivision of engineering department
- Continuous and integrated redesign
- Engineering profit into the product
- Designing for the "impossible" automated job
- Integrating size, complexity, quantity and cost
- One-piece design may not be best

A Product Engineering Special Report

DESIGN for AUTOMATIC MANUFACTURE

How design of product and machine to make it were integrated for a small transformer.

L. DeKANSKI, A. BONANNO, M. KALB

General Engineering Laboratories, AMERICAN MACHINE & FOUNDRY CO., Greenwich, Conn.

IDEAS YOU CAN USE...

- **Ribbon conductors an alternate to insulated wire for coils.**
- **Analysis chart provides a progressive guide to development.**
- **A dollar well spent in market research can save ten in development.**

Development of automatic production for a small transformer involved redesign of the product itself, taking into consideration processes, tooling, economics, material prefabrication, and future trends in customer applications. The problem was to create a fully automatic production line to economically turn out iron-cored foil-wound transformers, functionally equivalent to present manually assembled transformers with wire-wound coils. The project was initiated by the Air Materiel Command, USAF, to reduce manual labor and develop an alternative method not dependent on copper magnet wire and wire drawing dies.

In mechanizing an established product two situations may arise: If the design is fixed, the task is to design a process, more or less mechanized, that will produce this product; if only the function is fixed, the design of the product may be adapted to mechanization.

While development of this transformer could have proceeded either way, with design fixed the production machinery was prohibitive in cost. With only the function fixed, which permitted considerable room for fitting the product and the manufacturing process, the development required a new type of engineering activity: simultaneous design of the product and the process.

Previous investigation showed that a flat conductor for a transformer winding had the following advantages over a round wire: Better space and weight factors; better heat equalization and dissipation; use of non-critical rolled foil instead of potentially critical drawn wire; possible economic advantages in using foil ribbon instead of round wire; and better mechanization possibilities.

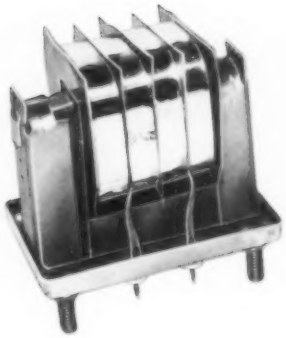
At the onset, the project was therefore restricted to the mechanization of ribbon conductor transformers, with each winding made up of ribbon-wound wafer segments—the basic element of the transformer. The wafer is a spiral, single conductor in width, with each turn placed upon the preceding one until the desired number of turns is obtained. A transformer winding is formed by connecting electrically one or more wafers.

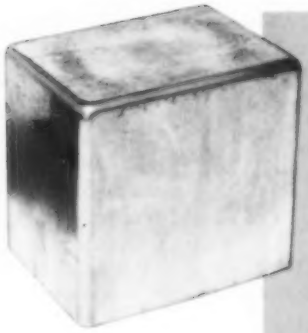
Cores usually are "EI" laminations, or tape-wound "C" cores. The high permeability of tape-wound cores is needed for some military applications, but radio and TV require the low cost and design flexibility of stamped laminations. Tape-wound cores aid mechanization in reducing the number of components.

Steps in the assembly of a wafer transformer are illustrated in Fig. 1. After the wafer is formed, it is moved to an assembly point and assembled into coils. The wafers are connected to form complete windings, and terminals added. After the core is assembled to the frame, the transformer is potted, dipped, or encapsulated, and then tested electrically.

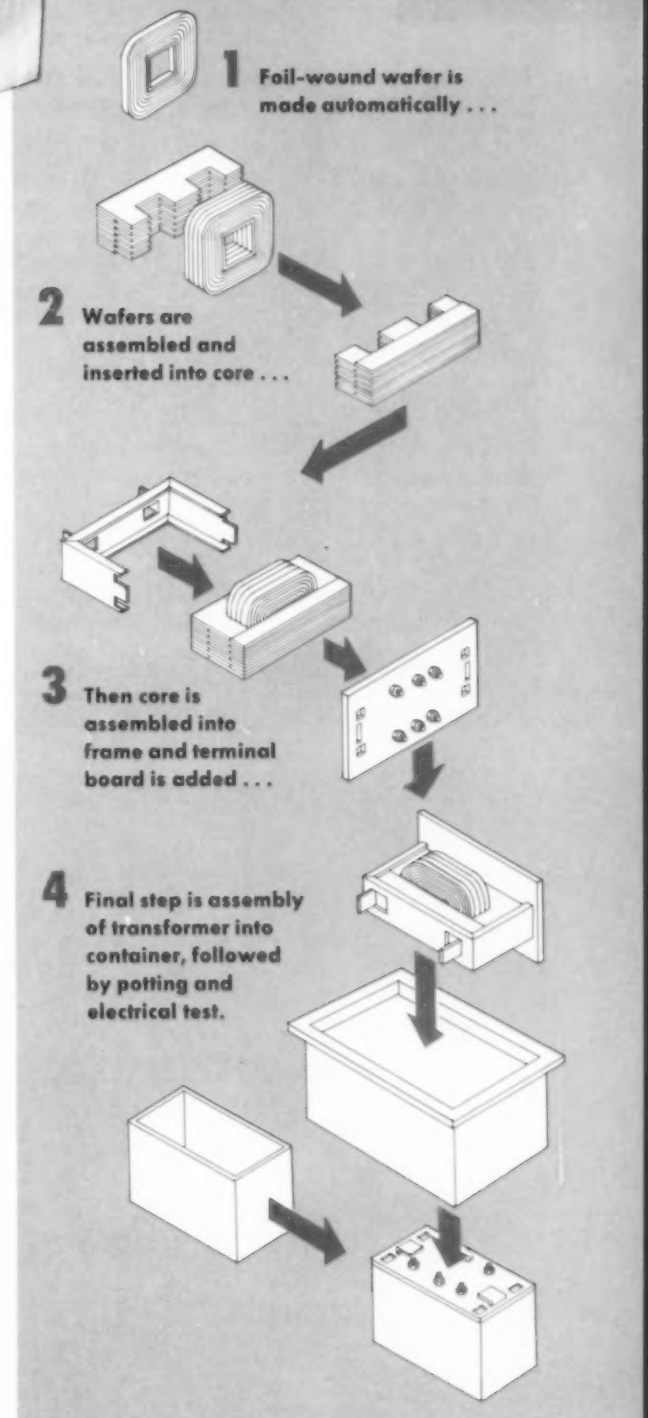
First Phase Development

In the first creative stage, general scientific methods must be diluted with "good guesses" to provide data for logical subdivision of tasks. But these "good guesses" can themselves be based on logical methods. For example, when preliminary technical aspects of a product





HOW ASSEMBLY WAS MECHANIZED


1 Foil-wound wafer is made automatically . . .
2 Wafers are assembled and inserted into core . . .
3 Then core is assembled into frame and terminal board is added . . .
4 Final step is assembly of transformer into container, followed by potting and electrical test.

are known, it is helpful to try projection of the "ideal" product. All desirable properties of the product are stated in terms of specifications, followed by an analysis of the obstacles faced. Such an evaluation is made to establish a reasonable approach, which may not necessarily be the right one, but one that can be defended with present (and not future) knowledge.

This initial evaluation is guided by such principles as: Selection of product areas, output rate, size of production runs, degree of flexibility required, and availability and cost of raw materials considered as starting elements in a given process. Other important factors are: capital investment in equipment; adaptability of equipment to different marketing needs; influence of selected processes on mechanization, cost of equipment, cost and quality of product, maintenance costs and personnel training. To this must be added, of course, considerations of practical feasibility—the size and capabilities of available technical personnel.

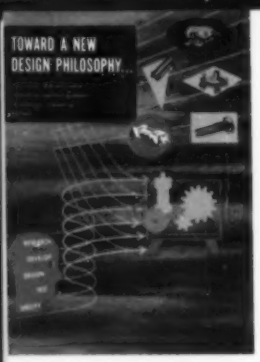
Second Development Phase

With all threads of product aspects in hand, technical objectives were divided into a number of logical elements or features of unequal value, some universal and some more or less dispensible, but each related in terms of a production process. It then became possible to set a progressive plan of acquiring information—the main content of any production research and development program. Analysis charts can be of important help here.

For example, in the preparation of the ribbon conductor for the wafer transformer, the analysis chart, Fig. 2, distinguishes some universal features from specific features, and shows all the various technical forms which can be considered as possible. Starting from the most generic features at the top and proceeding down, the features become progressively more specific. Horizontal correlation indicates alternative operations performed upon the material or product.

This chart was a part of the product analysis, which together with the process synthesis, was the main part of the manufacturing system. It shows vertically the progressive transformation of material in production and horizontally shows associated manufacturing operations. Starting from the bare foil stock strip, two classes of insulation are offered and also a choice of insulating one or both sides. Further down the chart, insulation may be achieved by two basically different approaches, by coating the foil or by interwinding with an insulating

CONTINUED ON NEXT PAGE



DESIGN for AUTOMATIC MANUFACTURE

film. Reducing to required width may be done by slitting followed by spooling or by winding wide widths followed by slicing.

Decision between these alternatives usually requires evaluation at each step by test. For example, all of the slitting methods produced foil ribbon and eventually wafers with some degree of burr at cut edges. The question then was the choice of method for satisfactorily deburring the wafer, or producing a burr-free product. Further experimental work among deburring processes, established that while both chemical (etching) and mechanical (sand blasting), are technically feasible, they lead to products which are either inferior or costly. The production of burr-free ribbon and wafers therefore was the subject of a special investigation.

Market Survey

Every dollar well spent in market research at an early stage of project planning almost always saves ten dollars wasted in misdirected development. Cost figures on present techniques are needed as a base for evaluating the competitiveness of the prototype transformer production line.

The market analysis brought to light some incompatibility in the objectives of military and commercial types as to both quantity and quality. This affects choice of the system. The cost of equipment may be very different for basically uniform or basically varied, basically small or basically large production. This situation, however, loses its critical aspect if the production capacity can be selected without sacrifice in cost.

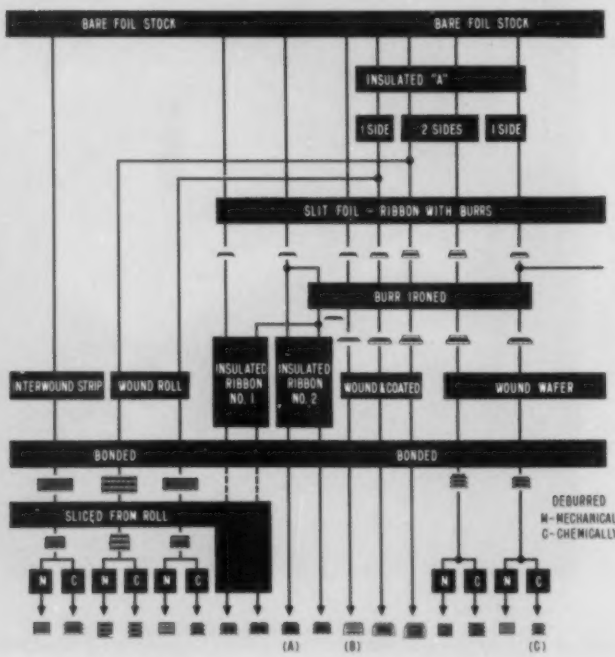
Joining Evaluations

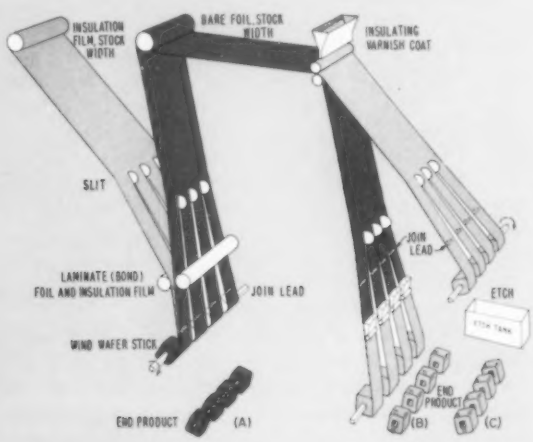
Since the final product was a winding, the inter-wafer and "customer" electrical connections were critical features. Electrical joining has always been one of the more difficult operations in the automatic assembly of electronic components. Various methods of joining aluminum to aluminum and aluminum to copper were studied: aluminum solder with flux, ultrasonic soldering without flux, cold welding, electric fusion welding, cold solders, mechanical joints, and metal spraying.

All of these showed serious limitations. No fluxes were found that did not have some corrosive effect on aluminum foil, and while ultrasonic soldering did not require clean surfaces, the method was "messy" mechanically. Cold welding required different tools for every thickness and the surfaces had to be clean and bare; condenser discharge welding required much redressing of parts, and a repetitive troublesome mechanization. Cold solders had not proven themselves, mechanical joints were not acceptable for military equipment, and metal spray of copper or tin gave poor bonding to aluminum. The choice, almost by default, finally rested on ultrasonic soldering. While technically feasible to mechanize, it meant unwieldy mechanisms.

Wafer into Coil Assembly

In the wafer process a coil is composed of one or more windings made from one or more wafers. Thus, the basic coil component needed is a wafer with two or more terminals. To determine the nature and location





Analysis chart, left, prepared to guide development of the foil wafer. Starting from basic elements at the top, lower levels show alternatives for progressively more specific features.

Three of these methods are shown in the process diagram at right

TOWARD A NEW
DESIGN PHILOSOPHY...

of suitable terminals for a wafer, three approaches were developed: Leads formed from the wafer ribbon, inter-wafer printed circuit cards, and terminal tabs. The first approach was difficult to mechanize. The wafer card method required a plastic card with several terminals and a short section of core tube, but it did provide accurately positioned terminals, supported narrow coils, and facilitated handling and transfer of wafers without disturbing inside turns.

Card production was studied first as an etched circuit, but costs and design requirements led to stamped laminate. The card required terminals at the winding arbor, which crowds a busy area with joining and card-manipulating equipment.

The cardless terminal strip design used the wafer coil itself as a support in which terminals were interwound as required. All joining, insulating and terminal preparation was accomplished on the unspooled wire just prior to the wind-up arbor. The wafer was bonded as wound to build a semi-rigid washer with terminals protruding. This type of coil could be tapped as often as necessary.

These examples of three solutions of the same functional problem, besides obtaining entirely different products, each required an entirely different type of production machinery, demonstrating the importance of considering the product and the process simultaneously.

In the final form of the wafer-making process spools or large rolls of conductor were slit from foil which was insulated on one face with a bondable coating. These rolls were fed into a winding machine which wound tensioned conductors into a wafer coil, added terminals and joined them to the conductors, and then cut off conductors and insulated the outside turns.

The terminal strip feeding unit and terminal attaching head, Fig. 3, were essentially stations of a conventional progressive die, and familiar punch press techniques were used. Terminal strip designs, simple or complex as required, were easily handled and set ups for different conductor widths made by changing guides and attachment heads.

Terminals were partially stamped and supplied in reel form. A length of this strip was passed across the strands and cut from the reel. After the terminals were bonded to the web of eight conductors, they were parted and carried into the wafer.

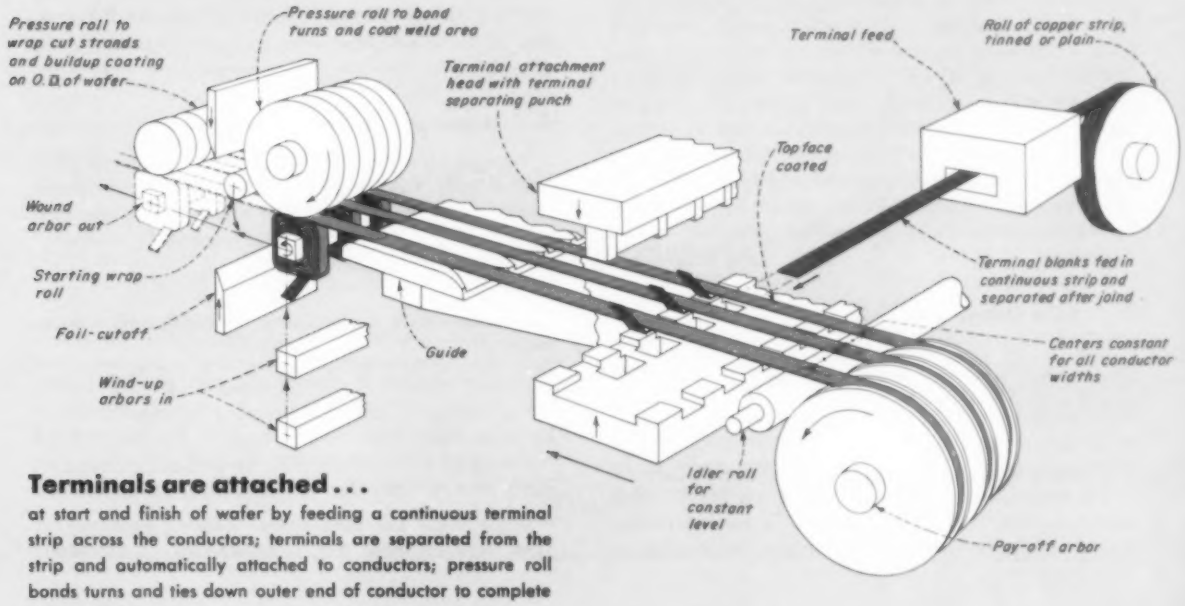
Core Insertion and Mounting

In developing this technique as many "fresh" ideas as possible were created. These ideas were then compared, and the feasibility determined by tests.

Strapping means for holding the C-core together was studied. Simplification and reduction of the number of parts going into an assembly required that means for holding the transformer together should be integral with the mounting. Development of a channel frame for this reduced the complexity of the assembly machinery, and tests proved the assembly would meet military specifications.

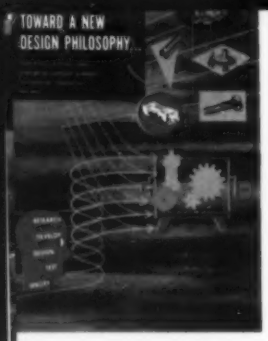
The channel frame used on smaller EI laminations was adaptable to mechanization and provided a rigid means for retaining the core as well as mounting to a chassis.

This example of design for automatic manufacture demonstrates the importance of systematic planning in integrating the several types of engineering functions involved. Systems engineering, development and product engineering, market studies and capital requirements all enter to modify and finally solve the general problem. The key element in such planning is **simultaneous** design of product and process, with continuous coordination and evaluation by joint effort—a committee in effect.


Pressure roll to wrap cut strands and buildup coating on O.D. of wafer
Pressure roll to bond turns and coat weld area
Terminal attachment head with terminal separating punch
Terminal feed
Roll of copper strip, tinned or plain
Top face coated
Wound arbor out
Starting wrap roll
Foil-cutoff
Guide
Wind-up arbors in
Terminal blanks fed in continuous strip and separated after joind
Centers constant for all conductor widths
Idler roll for constant level
Pay-off arbor

Terminals are attached . . .

at start and finish of wafer by feeding a continuous terminal strip across the conductors; terminals are separated from the strip and automatically attached to conductors; pressure roll bonds turns and ties down outer end of conductor to complete the wafer.



AUTOMATION...

who does it

FIVE varieties of automation; how method, design and process integrate to extend responsibilities of the product engineer.

WILSON H. HANNAHS, AUTOMATIC PRODUCTION RESEARCH MOUNT VERNON, NEW YORK

There are a lot of definitions of automation; one more is not needed. The subject has also suffered much ballyhoo, some direct misinformation, a little political footballing and voluminous interpretations, along with considerable forthright appraisals. And, recently, a few reports of technically significant advance in the field.

American automation seems less a concerted movement and more a mixture of yet incompletely blended schools or groups of engineering principles developed by technical and just plain practical people who have spent a little time with the problems of mass production. Are we really in the age of automatic production when there are still no textbooks on principles of mass production? It is a possible interpretation that mass production never rose above an art and that a science of production–classification, nomenclature, theorizing and research–has only begun. Of the precursory association of automation principles into schools, five can be distinguished:

1 . . Ford-Detroit automation.

Has as its basic thesis the automatic feeding of separate but sequential machines by auto loaders, conveyors and unloaders, to create a continuous line.

2 . . Automatic production of simple products.

The manufacture of structurally simple items–newspapers, aspirin, bread, candies, etc.–are reminders that what is probably the oldest art of mass producing individual items in sequential automatic operations was developed by the printing, food and pharmaceutical industries.

3 . . Automation as known to the servomechanism and instrument industry.

Developed primarily in heavy chemical and steel production where the continuous flow of fluids or webs (strips) through thermal processing demanded integration of successive operations and control-measurement of processes.

4 . . Automation of office procedure.

Volume requirements for vouchers, checks and other "paper work" embodying sequential calculations brought forth accounting machines with automatic programming of involved operations, with key-oriented "products," principles of storage, etc.

5 . . Automatic assembling of electronic equipment.

Mass production of complex electrical products comes with radical structural redesign in products introduced to make them manufacturable. Here we have printed wiring, packaged unit assemblies, and imbedded subassembly–for easier automatic handling.

While there has been some vitalizing exchange of ideas between these five fountainheads of automatic

TOWARD A NEW

production, their principles are by no means universal and in some cases are obviously incompatible. To attempt the compression of such a body of methodology to a single common denominator—as in the one sentence definitions below—is to lose the technical meaning of automation altogether.

Certain principles of processing are the outgrowth of a broad pressure of need associated with a particular industry. For example, feedback was a "must" between rolling stands on strip steel, and Yorkville had it before electronics feedback was available. Likewise, the keying or shaping of a product to fit a sequence of machines undoubtedly seemed most obvious in the handling of punched cards.

Analoguously, people engaged in automating industry today were not formally educated as automation engineers but rather persons who gained some experience as "production engineers," which is also a job description, not a university degree. The production engineer is himself a new breed born and bred on the manufacturing floor (together with the production foreman), who is responsible for the product as it flows in-plant. He has stood midway between the design department and the shop's production men who until recently held all knowledge of the art of making things. Time was when a "breadboard" from product engineering went directly into the shop to be made.

Mr. Production Engineer on the manufacturing floor has stood between two other office doors, too; while keeping-them-rolling, and faster, for the Manufacturing Superintendent, he was also held responsible by Quality Control to maintain the value of the individual product. Indeed the need for retaining quality in the new complex products, fragile to processing, largely created the need for the product shepherd.

This little-heralded middle man of production learned well because he shared everybody's problems, and when product development became itself a production line spouting new design after design, it was this man of all experience who usually became the king-pin known as Project Engineer.

When mass production burst the capacity of traditional methods to design, to produce and control, it was the production engineer who proposed the newer solutions; solutions to manufacturing that crossed and combined methods with design and design with process so that product engineering became a reality, and the centralizing vantagepoint of automation.

Definitions of Automation . . .

Funk & Wagnall: "AUTOMATION noun Automatic operation; also the theory, art, and technique of making a device, machine, or industrial process more fully automatic."

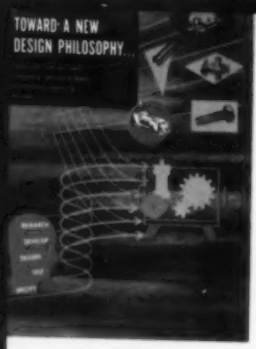
RETMA: "AUTOMATION is the technique of improving human productivity in the processing of materials, energy and information by utilizing, in various degrees, elements of self-control and product flexibility."

IRE, PGPT: "To promote technical progress in the design and manufacture of electronic equipment through manual or automatic means, by collecting and distributing information on new advances in methods, processes, materials and components. This includes the application of new materials and components and the details of how to improve operating simplicity, reliability, serviceability, cost and appearance of equipment of all kinds including miniaturization, encapsulation, circuit packaging and new assembly techniques."

The instrument industry (Aronson): "AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts."

These Committees Only Recommend

TASK GROUPS – one for each product – have for ten years past been involved in design and redesign at Reliance Electric & Engineering Co., Cleveland. There is a small motors task group, for example, another one for controls, one for ac motors, one for dc. Each committee includes the traditional four departments: Engineering, manufacturing, purchasing and sales. But the task group does *not* have authority over its members; each continues to administer his own responsibilities, according to Earl Barnes, assistant chief engineer. The company is currently subdividing its engineering setup, so design engineers concerned with a particular product will be at the plant which makes that product, rather than at headquarters in the Cleveland plant.



How automatic assembly affects PRODUCT DESIGN

Interviews with three engineers at AC Spark Plug Division, GMC, spot typical redesigns necessary to convert from hand to automatic assembly. The points they make are applicable to small parts for any product. The key word is "cooperate".

PRODUCTION ENGINEERING ANALYSIS

Date 12-15-56

PART NUMBER UF-27268 — PRODUCT OIL FILTER

PART NAME OIL FILTER ELEMENT — MODEL YEAR CONT.

REQ. NUMBER OF-41116 — CUSTOMER RESALE

Copies to:	DATE Rec'd	DATE Completed	PROCESSING TIME Methods	PROCESSING TIME Tooling	REQUIREMENTS PER YEAR	PRODUCTION DATE
Req. for Tool Routing						
Req. for Tool Estimate	12-7-56	12-15-56		8 HRS	850,000	AT ONCE
Req. for Eng. Action						
Req. for Eng. Change						

Survey Meeting Est. Meeting	Date	Invited to attend
NONE REQUIRED		

REMARKS AND RECOMMENDATIONS

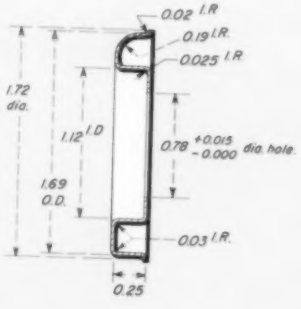
DESIGN O.K. EXCEPT ON END REINFORCING RING UF-27271, DIE LIFE WOULD BE INCREASED IF THE .065 DIA. COULD BE INCREASED. THIS PART WOULD LEND ITSELF TO AUTOMATIC HANDLING & ASSEMBLY IF THE .030 RADIUS WERE INCREASED TO .078.

By _____ TOOL ENGINEER — Supervisor Prod. Eng. — Appr _____ SUPERINTENDENT OF PROD. ENG.

This production-engineering analysis . . . form is filled out by tool-design and production-engineering personnel at AC Spark Plug after careful study of a part. On it they either approve a product as designed or recommend specific changes to suit automatic processing. This sample form has been filled out to cover the increased radius on the reinforcing ring illustrated.

Self-centering parts . . . can be located in an assembly without special locating devices. This reinforcing ring for an involute oil-filter element had a small internal radius. It is pressed into a sheet-metal tube. By altering the small radius to a large one, as shown, the part was made self-centering.

Unless otherwise specified tol allowed on two-place decimals is ± 0.010, three-place decimals is ± 0.005.

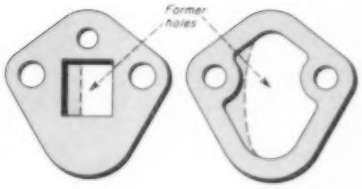


Interviewed in preparing this article were:

WARNER REMINGTON, chief process engineer
LLOYD CHRISTENSEN, supt of production engrg
CLIFFORD JOHNSON, director of production engrg

WATCH OUT FOR . . .

- **Pieces that interlock or rest**
- **Non-symmetrical parts**
- **Unnecessarily close tolerances**



These gaskets . . . were not symmetrical originally—quite all right for manual assembly. Redesigning these asymmetrical parts as shown avoided special selecting, flip-over and locating devices in the automatic machine which now assembles the pumps.

Product designers and equipment designers will be forced to work together to achieve maximum results in efficiency and economy as the current trend toward mechanized assembly develops. Meetings in the early stages of design are most desirable, so that each side will develop sensitivity to the problems of the other. This is particularly important where actual manufacture is subcontracted to a specialist company, if maximum economy is to be achieved.

Product designers must particularly keep in mind those elements of a part that affect automatic locating, loading, unloading, segregating, and escapement devices. Wherever possible, parts should be symmetrical to simplify hopper feeding, minor design elements should be standardized to avoid special tooling and added setup costs, tolerances should be liberal, small parts should be designed so they do not tangle or mesh when piled, and radii and tapers should be applied on nesting elements for self-locating.

For example, AC makes pressure switches for a number of different automobiles, each switch with its own little variations in design. Slight differences in size and shape of components which could be alike run up costs for everybody. Different types of terminal posts do exactly the same job, one with cylindrical pins, one with flat posts; a third with a double-snap arrangement. Each design group has worked up its own variation, with a resultant increase in processing costs—for fixtures, locaters, and other machine elements.

(This same point has been made again and again, notably in a recent speech by the manufacturing vice-president of Temco, Inc., Dallas, an aircraft sub-contractor. He showed many examples of special-design washers, clips, brackets, and like small parts in which costs were several times what they should be because aircraft producers have not standardized even such bulk-quantity, unimportant elements.)

Again, all fuel strainers have a bail-and-nut assembly to clamp the glass bowl to the head. Some have open slots into which the bail can be *snapped;* others have holes into which the bail ends must be *inserted*. The latter design is required to permit inverted installation, but it can be modified by a breakthrough or slot over the hole into which the bail can be snapped, thus guided into the hole. Now, these two designs make major differences in assembly equipment required.

Another assembly headache are the internal bosses on fuel-pump covers. All do the same job—provide a seat for a gasket and a port for fuel—but the bosses have various heights, square corners that prevent automatic assembly of gaskets, and no tapers for lead.

For manual assembly, such differences are unimportant, but in automatic assembly they raise hob. As a result, AC has found it necessary to provide a group to review design features and suggest design changes while the assembly equipment is being planned.

Cooperative planning of design and production equipment has been done in more-cost-conscious companies for years, of course, but the advent of automatic processing makes the necessity for this cooperation much more acute. In general, the longer and simpler the run, the greater the likelihood that automatic assembly will be practical. A spark plug—which has a long design life—is an ideal product for automatic processing; a part such as door hardware that is restyled frequently is not. Frequent changes in product design, or variations in design of component elements, may make for such short runs that the economy of automatic processing is destroyed.

Many special shapes are primarily aesthetic. In some cases, this is advisable; in most small parts, it isn't worth its cost. The same goes for small radii and square, straight bosses that make quick assembly impractical. And likewise for unnecessarily close tolerances (one of the production man's hoariest complaints).

Then there are parts that interlock or nest. Coil springs are an excellent example. Unless ends are closed and ground flat, they entangle, and that means a machine that is automatic except for an operator to load springs manually, frequent stoppages while he unsnarls parts, and like difficulty. If springs must be open-ended or have snarly shapes, the remedy is to put an automatic spring-winding station in the machine that makes parts as they are used. That, however, is an expensive remedy.

While it seems to be an obvious thing, many designers forget relatively new (even automatic!) equipment already installed in processing plants, and create new designs that obsolete expensive equipment or force costly and time-consuming changes. The quality or functioning of a redesigned part should not be jeopardized by compromise to suit existing equipment, of course, but in many cases no such considerations exist.

Compromise between design and production ideals can usually be achieved. On one pressure switch, for example, a venting groove down the outside of a plastic body had to be aligned with a mating slot in another component before the assembly would function properly. A tricky redesign to eliminate the necessity for alignment makes the switch suitable for automatic assembly. But in other cases such redesign cannot be done. Then the process engineer must come up with the tricky solution. Only real cooperation and a give-and-take attitude on both sides can make the new methods work.

Cost-reduction committees . . .
meet fortnightly to compare notes on project developments. This is the committee on the canister vacuum cleaner. H. D. Kelty, sales manager and chairman, is at right center, with his assistant, G. D. Sherman, on his left. In order are E. L. Davis (Costs), A. J. Grodin (Purchasing), and B. L. Study (Industrial Engrg). At left center is J. W. Pickford (Design Engrg), and, in order, S. S. Prackneck (Mfg Engrg), R. W. Bennett (Mfg), C. E. Roberts (Quality Control), and W. C. Keating (Order).

COMMITTEE

Engineers Profit Into Price

IDEAS YOU CAN USE . . .

1. **Sales manager knows what his selling features cost.**
2. **Design is for a known market at a known price with a known profit objective.**
3. **A committee combines all plant functions in control of design. This is not limited to "big-plant" operations.**
4. **Redesign is continuous, not periodic, so savings can be made quickly.**

E. J. TANGERMAN, Executive Editor

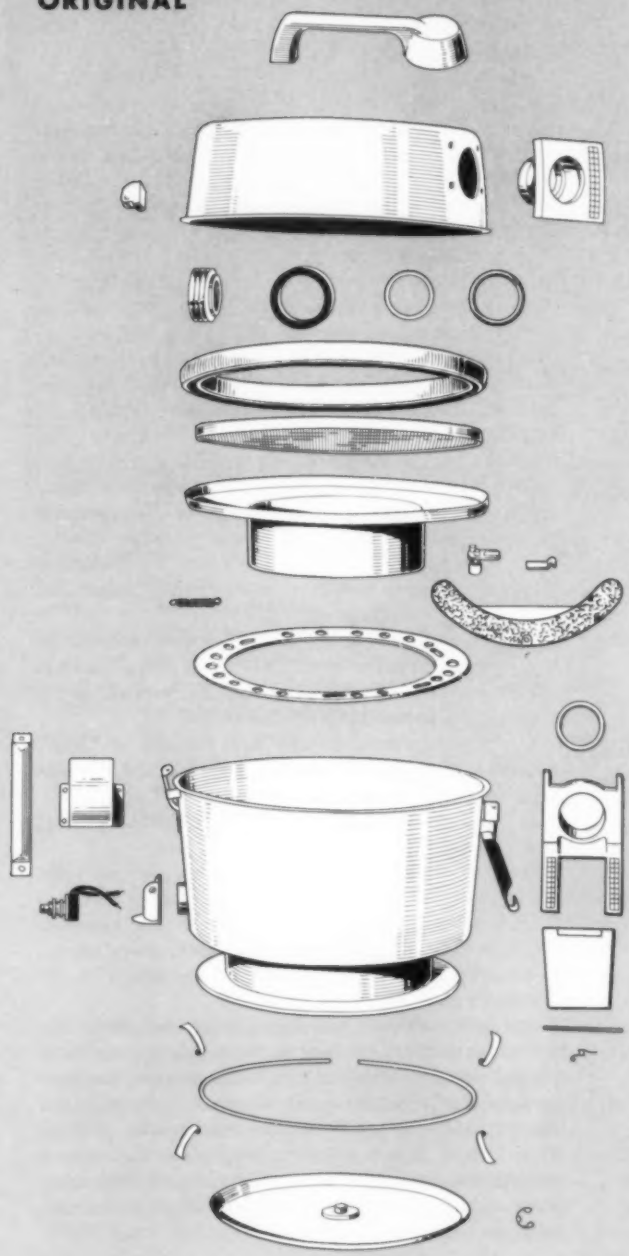
Fractions of a cent, saved at once rather than in some future model, are the objectives of a unique cost-reduction committee setup at the Westinghouse plant in East Springfield, Mass. Here is an on-the-spot report of how the system works, where savings are found, an unusual way of engineering profit into the design, and how coordination between departments beats skyrocketing base costs.

TEXT BEGINS ON PAGE 146

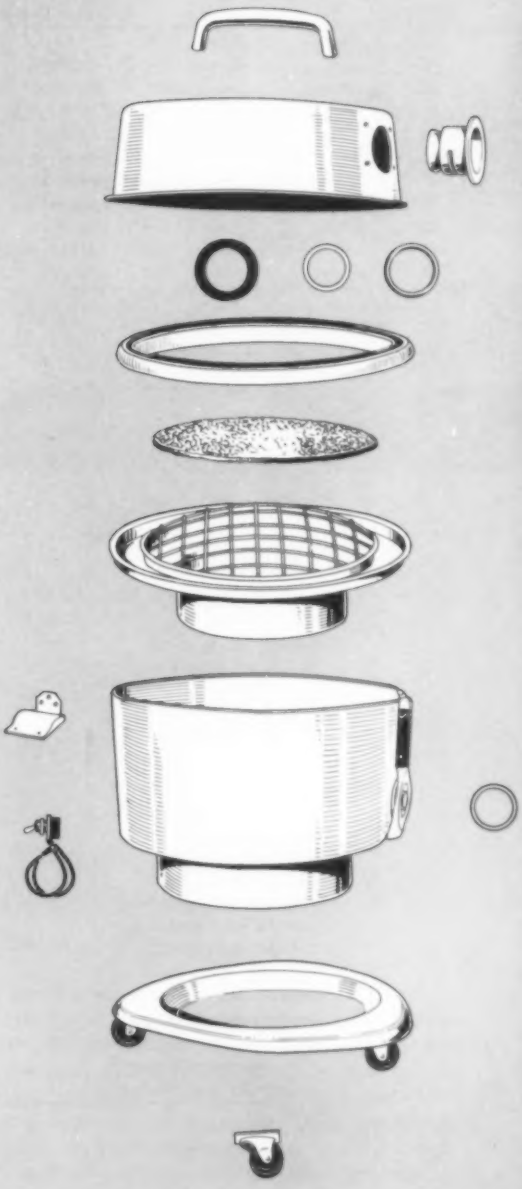
Redesign to cut costs . . .
on a highly competitive product is more likely to be many small changes, each saving a few cents or improving a sales feature, rather than a major model change. Comparison of the original DC-7 cleaner (left) and the current SC-2 (right and cutaway view) unit shows some of the changes. Parts were reduced from 93 to 61, and remaining ones have almost all been altered.

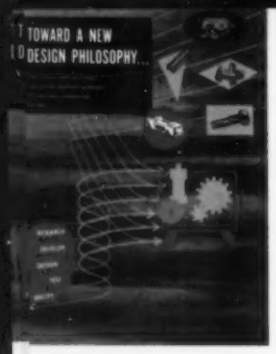
SIMPLIFICATION . . .
is typified by comparing housing elements of original and current models of the canister cleaner

ORIGINAL



CURRENT





COMMITTEE Engineers Profit Into Price

CANISTER VACUUM CLEANER WORKS DELIVERY COST

Model		Date	Major Change	%
DC-7	initial	July 1, 1954		100.0
DC-7	final	Dec. 1, 1954	Methods	91.6
DC-7	change	Dec. 1, 1954	Redesign filter	86.3
DC-7	final	Aug. 1, 1955	Labor, matls	90.2
DC-7	change	Aug. 1, 1955	Stripped	84.3
DC-7	final	Oct. 1, 1955	Short run	84.2
SC-1	initial	May 1, 1956	Redesign	71.2
SC-1	final	Sept. 1, 1956	Less decor	70.2
SC-2	initial	Sept. 1, 1956	Redesign	61.3
SC-2	intermediate	Nov. 1, 1956	Change diffusion	62.0
SC-2	current	Feb. 1, 1957	Details	61.3

Performance of unit and of attachments improved and all material and labor cost increases absorbed.

SOME TYPICAL COST SAVINGS DC-7 MODEL TO SC-1 MODEL

Change	Savings, %
Omit sprayer	100
Omit moth-crystal unit	100
Change chrome plate from high luster to satin	59
Change handle design	17
Eliminate cord clamp ring	100
Eliminate attachment kit	100
Supply 2 filter bags	33
Redesign attachment tube	61
Simplify final assembly	13
Change lower shell	3
Change filter bag	32
Alter sound insulation	100
Reduce braces	50
Remove hinge bracket	100
Change base and exhaust design	48
Estimate escutcheons	100
Change toggle switch	55
Redesign latch	32
Redesign two nozzles to one	35
Do own plating	89
Change spray-paint method	15
Make nozzle and baseplate	37
Renegotiate purchased small parts	26

Redesign of a highly competitive product is not an occasional thing; it is a continuous process of hunting savings to the fourth decimal place. Design in the first place is rigidly confined by price, quantity, competing products, and sales features. It is continually under examination because of rising labor and materials costs, changing processes, new methods, and a host of other factors. It cannot be static, even for a year or a month, or the product will suffer losses from which it may never recover. This expains in part why some 17 large appliance firms, including Bendix and Crosley, have gone out of the business since World War II.

Facing this problem at the Westinghouse plant in East Springfield, Mass, J. R. Weaver, manager, Engineering & Manufacturing, established an unusual system. It involves cost committees, certainly not a new idea, but the application and methods in this case are new. There are eight separate committees on cost reduction which meet fortnightly, one on each product. They include: Mobilaire fans, canister vacuum cleaners, food mixers, food-waste disposers, room air conditioners, water coolers, dehumidifiers, and Coca Cola coolers.

Nine separate departments are represented on each committee: Sales, Design Engineering, Manufacturing Engineering, Industrial Engineering, Plant Superintendent, Purchasing Department, Cost Department, Order Division, and Quality Control Department. This committee determines policy, sets bogies, schedules production starts for the redesigns it initiates. It analyzes competitive products, studies redesign or other projects involving change and assigns them priorities. Lastly, it acts as a steering committee for a working committee consisting of shop people, time-study men, inspectors, and methods specialists.

The product sales manager is chairman. Because he is frequently "on the road," his in-the-office assistant acts for him at routine meetings. But the responsibility is always his. This has two great advantages:

1. He is impressed directly with the cost of "frills" and sales features he may wish to add, and so must compare their value with their cost.

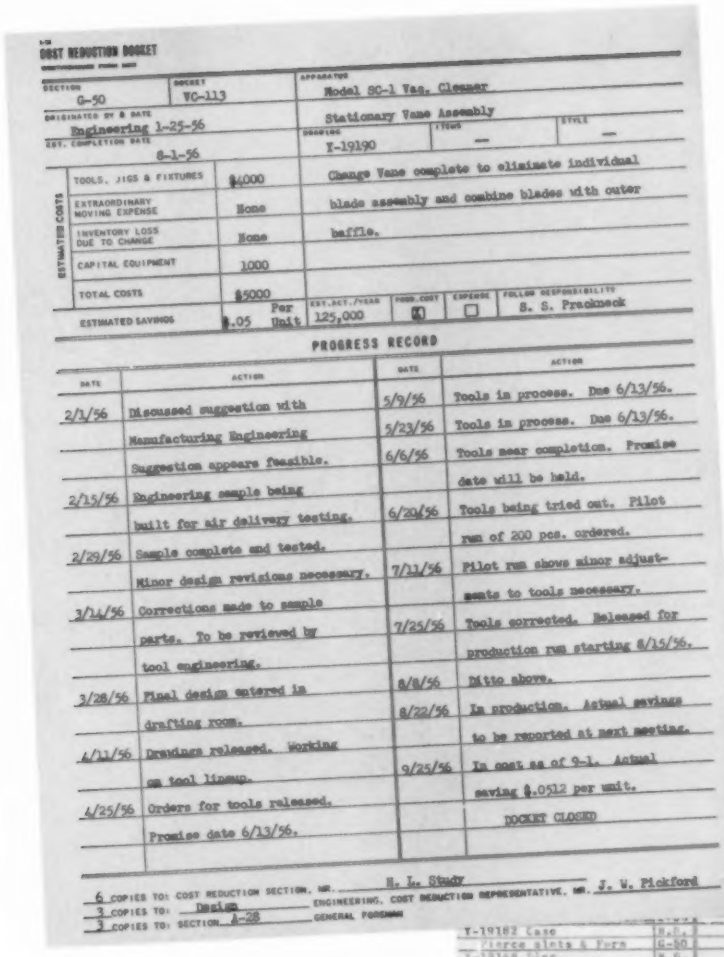
2. He is familiar with market requirements, pricing, and the competitive situation.

Experience with this system during the past two years has been good. Sales managers vary in their demands for sales features, finishes, capacities, and other elements, but in general they are required to justify every change to the committee – which forces them to take a careful look themselves first.

The sales manager must also go on record for the estimated number of units to be produced, the peak production rate required, any sales features he must have, and the selling price. From this information, monthly and yearly bogies are established by product. This, in turn, is converted into bogies for departments and sections, i.e.; Order Service, Shipping, Warehousing, Receiving, Transportation, Packing, Design, Office Systems, and Advertising.

TYPICAL CURRENT PROJECTS

Docket	
44, 87	Rearrange armature manufacturing setup
65	Change steel type for motor stampings
84	Change burring method (Dead – did not save money)
90	Carbide dies in heavier press to increase die life 35%
104	Eliminate commutator grinding with new boring machine
114, 118	Make outer and inner fan cases instead of buying
131	New motor design
137	New screen design
139	Improve trimming die on upper shell (Dead – not feasible)
141	Recapture plating of connector-tube sleeve (Results from purchase of $500,000 Udylite automatic plater, which paid for itself in 1½ yr)
143	Change drawing compound to avoid final wash (saves $0.05/unit)
146 (new)	Hose lock of tubing instead of flat stock to cut 5 operations
147 (new)	3-station die (to avoid materials-handling between machines)



COST REDUCTION DOCKET

SECTION G-50 | DOCKET VC-113 | APPARATUS Model SC-1 Vac. Cleaner

ORIGINATED BY & DATE Engineering 1-25-56 | Stationary Vane Assembly

EST. COMPLETION DATE 8-1-56 | DRAWING Y-19190 | ITEM — | STYLE —

ESTIMATED COSTS

TOOLS, JIGS & FIXTURES	$4000
EXTRAORDINARY MOVING EXPENSE	None
INVENTORY LOSS DUE TO CHANGE	None
CAPITAL EQUIPMENT	1000
TOTAL COSTS	$5000
ESTIMATED SAVINGS	$.05 Per Unit

Change Vane complete to eliminate individual blade assembly and combine blades with outer baffle.

EST. ACT./YEAR 125,000 | FOOD COST ☒ | EXPENSE ☐ | FOLLOW RESPONSIBILITY S. S. Frackneck

PROGRESS RECORD

DATE	ACTION
2/3/56	Discussed suggestion with Manufacturing Engineering. Suggestion appears feasible.
2/15/56	Engineering sample being built for air delivery testing.
2/29/56	Sample complete and tested. Minor design revisions necessary.
3/14/56	Corrections made to sample parts. To be reviewed by tool engineering.
3/28/56	Final design entered in drafting room.
4/11/56	Drawings released. Working on tool lineup.
4/25/56	Orders for tools released. Promise date 6/13/56.
5/9/56	Tools in process. Due 6/13/56.
5/23/56	Tools in process. Due 6/13/56.
6/6/56	Tools near completion. Promise date will be held.
6/20/56	Tools being tried out. Pilot run of 200 pcs. ordered.
7/11/56	Pilot run shows minor adjustments to tools necessary.
7/25/56	Tools corrected. Released for production run starting 8/15/56.
8/8/56	Ditto above.
8/22/56	In production. Actual savings to be reported at next meeting.
9/25/56	In cost as of 9-1. Actual saving $.0512 per unit. DOCKET CLOSED

6 COPIES TO: COST REDUCTION SECTION, MR. H. L. Grady — ENGINEERING, COST REDUCTION REPRESENTATIVE, MR. J. W. Pickford
3 COPIES TO: Design
3 COPIES TO: SECTION A-28 — GENERAL FOREMAN

Changed to Vanes formed from flat disc and spot welded instead of using 8 single Vanes which have to be fitted and upset with air press.

Effective 9-1-56

Each project . . .

carries its own docket number, is supplied to all committee members by duplicating. This is a typical one, now completed, with the work sheet from which it is derived. Each member maintains his own appraisal of progress (lower two-thirds of sheet), based on reports at meetings. Each docket is considered at each meeting until closed out as completed or unfeasible.

Contemplated new products go directly to the appropriate committee, and are there examined in detail. Old products are continually under the committee's eye – and it is their decisions that make changes, reduce or increase models, or even terminate a product as unnecessary or unprofitable.

Perhaps one of the more unique methods of these committees is that used to "engineer profit into the product." That it works is evidenced by accompanying tables and the simple statement that one committee has made savings running well into five figures *per day* by cutting costs over 10% in the face of materials and labor increases, plus an increase in costing rate of $1.90 per hr because production of domestic refrigerators was transferred to a new plant at Columbus, Ohio, during the period. (This cut production hours at Springfield almost in half). *And this was done without cutting performance of the appliance* – in fact, *it was improved.*

CONTINUED ON NEXT PAGE

COMMITTEE Engineers Profit Into Price

An unusual method, proposed by Don Burnham, vice-president, Manufacturing, is followed in determining desired cost. Sales price is usually established by prices of competing units. From this price, 20% is subtracted as desired return on investment. The remainder is the target cost, incorporating all engineering, production, handling and sales expenses.

Usually, target cost is well below initial cost; it represents something to shoot at, and indeed may never be achieved. But some targets are met, and some surpassed eventually, despite continuing rises in labor and materials costs. Based on rough models or mockups, a new product is developed – or an old one redesigned – from sales-potential data, each committee member contributing his part of necessary added information and his best thinking on design, components, and methods. Competitive models, if they exist, are purchased, dismantled, and studied, each part being given a material cost, setup and running time, as well as estimated equipment required. (Some five competing canister cleaners were thus analyzed, a hard-bitten procedure, but one justfied by the currently highly competitive situation. There is no room for laggards).

All such information is evaluated by the committee, then it goes to Sales and to Design Engineering to establish the product. The aim at this stage is to match the biggest competitor, then to add one feature (preferably patentable) that the competitor does not have. (A good example of this is the air-injector rings on the Mobilaire Fan.)

The design engineer produces preliminary drawings which are routed for each manufacturing and assembly operation so cost reduction can be engineered in through application of the best methods, tools, and equipment. Hand-made samples come next– and receive the same treatment. Then come tool-made samples, which are tested so quality-control standards can be set. Packing, shaker, and accelerated-life tests are made, plus a careful check of models against drawings to search out variations. If these variations do not affect functioning or appearance, and save money, they are accepted and the drawings changed. Then the unit is ready for its production run.

But the seeking for pennies to cut from cost never ceases, because target cost has still to be met. Every docket that proves out a saving is incorporated, so the model gradually changes in details. Only in this way can continually rising costs be compensated for, competing improvements counterbalanced, and a desirable profit margin attained.

SC-1 to SC-2 Changes and Resulting Savings
(Expressed as percentages of the Total Saving)

	%	Tools, $
Change dust bag to bottom inlet, with plate and rubber gasket	0.91	
Omit gasket on dust inlet because of above	1.21	
Change filter from vacuum-cleaner cloth to felt, change support	6.80	1500
Change motor support to eliminate redraw	2.25	2000
Make redesigned motor insert, instead of buying oustide*	2.41	5550
Redesign hinge to three parts for simplicity	5.06	3600
Redesign bumper-seal for less rubber stock	3.03	90
Diffuse air through blower; eliminate slots and valve	1.34	4000
Omit braces, screws and holes as a result of above*	4.47	
Redesign dolly for stability: casters from 4 to 3, rivet to plate	2.48	750
Make lower shell instead of buying**	22.38	21,000
Change facing methods on upper shell (avoid deburring)	0.61	980
Dip-paint two dollies at once	2.11	450
Combine pierce and stamp on dolly (omit rating plate)	0.76	
Change burr removal on dolly (by adding bumper)	0.91	
Make dolly from strip instead of sheet	0.61	125
Redesign air vane for spotweld assembly from punched parts	2.57	5500
Blanket-order carbon brushes	3.91	
Mechanize wedging of armature	4.31	2000
Eliminate grinding of armature OD by closer blanking	1.44	
Eliminate one grind on commutator by closer blanking	0.97	
Eliminate staking of lead wires before pot-soldering	1.43	
Wind motor primary on poles instead of separately	5.44	
Revise method of building primary core	1.19	2700
Eliminate grinding of primary core as a result	1.55	
Reduce machining on motor housing and bracket	7.26	1800
Replace tape with wire ties on motor assembly	0.79	
Change floor nozzle from acetyl butyrate to polystyrene	2.27	
Expand swivel elbow on Vaill machine instead of press	0.61	200
Price cut in hose cost by supplier***	0.60	
Reduction in general assembly cost	6.87	
Reduction in inspection and test cost	0.54	
Simplify packing method	0.91	
	100.00%	$52,245

*—Actual saving 25% higher
**—Actual saving 30% higher
***—Design change since saved three times this saving

Vacuum Cleaner Committee

To show how cost-reduction committees work, we have selected the one on the canister vacuum cleaner. Accompanying tables list its projects and their results, figures on two tables (to four decimal places) being replaced by percentages to mask detailed costs. The tables and pictures show results of cost dockets we studied during a meeting of this particular committee. It is responsible for elimination of 32 of the 91 parts of the original cleaner, considerable change in most of the remaining ones, a cut in costs of almost 40% despite materials, labor, and costing-charge increases – all with no loss of cleaning efficiency or over-all product performance.

Each member of the committee has a binder containing copies of all current dock-

ets, and each man keeps his own record of progress. Each docket has a sponsor, usually – but not necessarily – the man from the appropriate department, who reports on it in its numerical order at each meeting until it is completed. As it develops from one department to another (i.e., from Design to Manufacturing Engineering), a progress report is made by the appropriate man. Each report gives an expected phase-completion date and a project-due date. This method eliminates debate over actual decisions at earlier meetings, and pins responsibility on the proper department at any given time.

On this particular product, only one part has not been changed – the cover. The handle was simplified, to save $0.0321, the seal ring between upper and lower shells was changed to cut cost 1%, the filter redesigned to save almost twice that, and so on. Some of the changes are in design, some in materials, some in method, even some in purchasing or order-handling procedure, but all are aimed at a common objective – to cut the works delivery cost below the target cost and end up with a better product.

Most cost savings usually result from design or manufacturing changes, but they may have been suggested by some other department. The Sales Department is obviously a major factor in the portions of cost represented by appearance and finish. The Order Department can save by improving its procedure or contracts with outside vendors. Purchasing may suggest that a particular part be made or finished in the plant rather than outside. Under committee control, it is less important to establish credit for a particular saving than it is to get that saving into the cost of the product quickly.

Multiple Committees Consider Customer Acceptance

At F-M, redesign is handled in traditional fashion, except for an unusual method of charging major changes and a belief that one-piece design may not be best. From an interview with . . .

GORDON ANDERSON, JR., assistant chief engineer, FAIRBANKS, MORSE & CO.

Increased customer acceptance is the goal of most redesign at Fairbanks-Morse & Co., particularly of major development and research. Day-to-day modification and cost-reduction problems are handled by committees at each plant, with management, engineering, production, and manufacturing engineering all represented. These committees also handle adaptations of standard products for special uses and consideration of redesign for mechanized production – basically, anything that can be shown on an engineering change order. Frequently, however, these changes are made to increase customer acceptance.

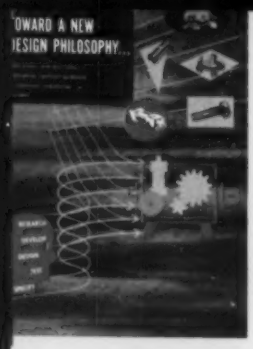
Major redesign of lines or products is handled by the research and development committee at the corporate level. Its personnel consist of president, vice-president–engineering, vice-president and assistant to president, vice-president and controller, coordinator government business, vice-president–sales, and vice-president–manufacturing. Objectives may be cost reduction, rerating, modernization, adaptation of new processes, or simplification, but they all incorporate increased customer acceptance. This committee also stimulates and examines major proposals from plants.

An interesting sidelight of this committee's activities is that simplification is a frequent factor – in design, or in manufacturing method. Frequently, automation is *not* the answer because of its inflexibility and tremendous cost. Frequently, also, a two-part design may prove better in the long run than a one-piece design – the opposite of the trend of a few years back. The policy at F-M is now to go back to the raw material and the basic processes, and to build the new design and methods from there – a technique called "modifying fundamental processes" – rather than to improve current processes.

Committee Considers All Costs

The company committee has four general areas of activity: customer acceptance, research, development, and cost reduction. It is in a position to consider *all* costs: inventory, capital investment, sales, and the like, as well as the familiar materials, labor and burden. Thus, sometimes a design that saves money based on the three basic costs is found to be no saving when all costs are considered. It may force excessive handling or inventory, may freeze or specialize a design or narrow its applicability and thus reduce customer acceptance. It may require plant modification for a wide or special application, while company experience indicates that field modification is cheaper and better.

A company-level committee obviously has great power – power enough to require that a desired change be made. This, in some companies, leads to an open breach between company and plant. F-M has a unique system to avoid this, as well as the unfair burden of a major change or development project placed on a small plant. If plant management is doubtful of a suggested project, or its budget is abnormally great, costs are placed in a special development account. Plant management then receives two profit-and-loss statements, one on the old basis, one on the new, so the change creates no hardship.



PRE-PRODUCTION

TV & Radio Master Schedule

Issued By Production Control

See Notes On Reverse Side

MRR No.	Date	Quantity	For	GLD
C- 3699	2/2	10,000	230180	Chassis 230180

Model

Next Issue (Approx.) 5/20 | 6/16

Description 17" Front tuned TV chassis

Divisions Responsible					Item No.	Function	Time Schedule, as of: 5/20			Completed By
P.C. Sales	Tech. Mgt. S.S.	Pur.	Whse.	Engr.						
	Mgt.			E	1	Cabinet Design Approval				—
				E	2	Lab. or Breadboard Sample				2/20
				E	3	Estimate B/M				—
		F	M		4	Preliminary Labor and Material Cost				—
	Ac.				5	Preliminary Cost Estimate				2/2
	Mgt.				6	Management Release				2/21
	S.S.		M	E	7	Interdivisional Review Meeting				—
S				E	8	Eng. & Sales Review Meeting				2/27
				E	9	First Eng. Sample				3/3
			M	E	10	Additional Samples				—
				E	11	Preliminary Tool Release				3/11
				E	12	Final Tool Release				3/12
				E	13	Final Cabinet Drawing				—
				E	14	Preliminary Field Test				3/19
				E	15	Bills of Material				3/21
				E	16	Specifications Released				2/20
S				E	17	Prelim. Specs. For Sales Literature				—
					18					3/27
P.C.					19	Material Requirements Posted				—
P.C.	S.S.				20	Service Sales Requirements Posted				3/21
				E	21	List of Uncommon Preprod. Material				4/10
		P			22	Purchase Orders Placed				3/25
			M		23	Preprod. Critical Report Started				—
				E	24	Prelim. Schematic To Service Sales	4/22			
				E	25	Layout Sample To Preproduction	5/15			
		P	M		26	Final Labor and Material Cost	5/18			
	Ac.				27	Final Cost Estimates	4/29			
		P	M	E	28	Preprod. Material Available (15)	5/1			
			M		29	Preprod. Started	5/8			
			M		30	Preprod. Chassis Assembled (10)	5/15			
			M		31	Preprod. Chassis Tested				
					32		---			
		P			33	Preprod. Cabinet Mat. Avail.	---			
				E	34	Samples To Underwriters	5/17			
				E	35	Standard Field Test	5/17			
				E	36	Schematic For Service Notes	5/19			
S				E	37	Confirm. of Specs. For Sales Lit.	5/18			
				E	38	Eng. Approval of Preprod. Chassis				
					39		6/1			
			M		40	Production Critical Report Started	6/15			
			M		41	Equip. Available	6/15			
			M		42	Production Facilities Available	---			
				E	43	Verbal Eng. Approval of Model	6/11			
			P		44	Vendor Tooling Avail. - Metal Parts	---			
			P		45	Vendor Tooling Avail. - Molded Parts	6/15			
P.C.			P		46	Production Material Available	---			
				E	47	U.L. Approval (Less Shop Insp.)	6/26			
	S.S.				48	Service Notes Prepared	6/18			
				M E	49	Eng. Approval of Complete Model	6/22			
				M	50	Start Production				

Rheem Form 117 - Rev. 3 - 8P.

MANUFACTURING COMMENTS AND REQUESTS FOR CHANGES ON CHASSIS 230180

1 The printed board should have a center support to prevent flexing. This support must not interfere with the test fixture.
2 Provide mounting for the molded capacitor to prevent whipping and breakage.
3 Production will study the placing of the picture tube warranty label. (Possibly on the neck of the tube.)
4 Engineering to run tests to determine if some of the picture tube bracketry can be eliminated or simplified.
5 A major problem exists in scheduling due to the use of three different sized mounting boards. Can we standardize?
6 Engineering to specify black tubing on tube holding bracket fingers. Manufacturing to use black tape until sleeving is available.
7 All sockets with shields should have self-retaining shield.
8 Provide notch in front metal frame bracket for leads to come through to tie points.
9 Mounting lugs on coils should be changed to prevent breakage.

Partially completed schedule . . .

in the development of a new TV chassis (left) and what happened at a typical meeting of the engineering committee (right) held before tooling and bill of material were ready for release.

ENGINEERING

. . . by committee

How Emerson organizes design skills for automatic assembly

to get all changes made before production starts.

PHILIP S. SUSSMAN, manager, Advanced Manufacturing Engineering, EMERSON RADIO and PHONOGRAPH CORPORATION

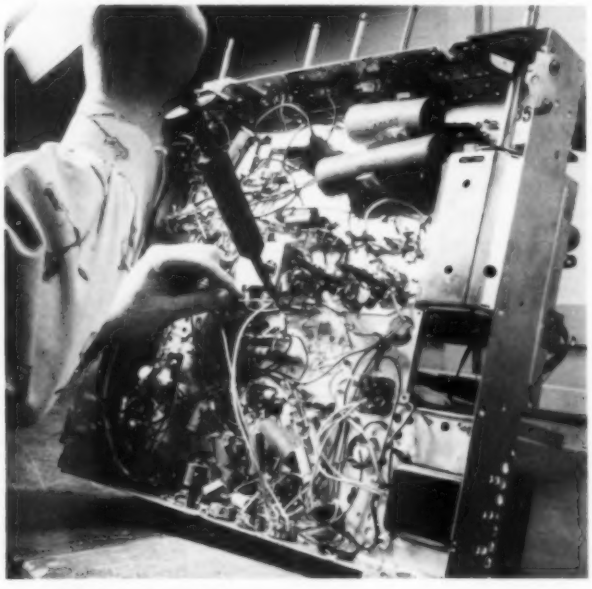
IDEAS YOU CAN USE . . .

- **Printed wiring plus automatic assembly reduce labor content.**
- **Assembly machines lack the flexibility of manual means.**
- **Someone must stand guard over performance.**

When management decides that a new radio or TV set is to be produced at Emerson, circuit designers work out their problems, and an acceptable appearance design is developed. Then design for production is started, working against stated material cost and performance objectives. A "Master Schedule" indicates and coordinates the time plan required to get a new design into production. It is kept up to date and re-issued regularly.

As can be seen by the "Master Schedule", the manufacturing division plays an important part in determining final design through the Pre-production Group and the Engineering and Manufacturing Meetings. The Pre-production Group – through its close continuous contact with Engineering, through the building of engineering samples, and through the pre-production sets it makes– is constantly checking to prevent production difficulties and reduce costs.

Manufacturing-engineering committee meetings are held to discuss and evaluate each new model before it is released for tooling or purchase of material. The engineering group consists of the electrical and mechanical designers assigned to the set, and the chief mechanical and television engineer. The manufacturing group consists of production, pre-production, methods, test engineering, and quality-control supervisor. Normally, service sales is also represented.



Printed wiring . . .

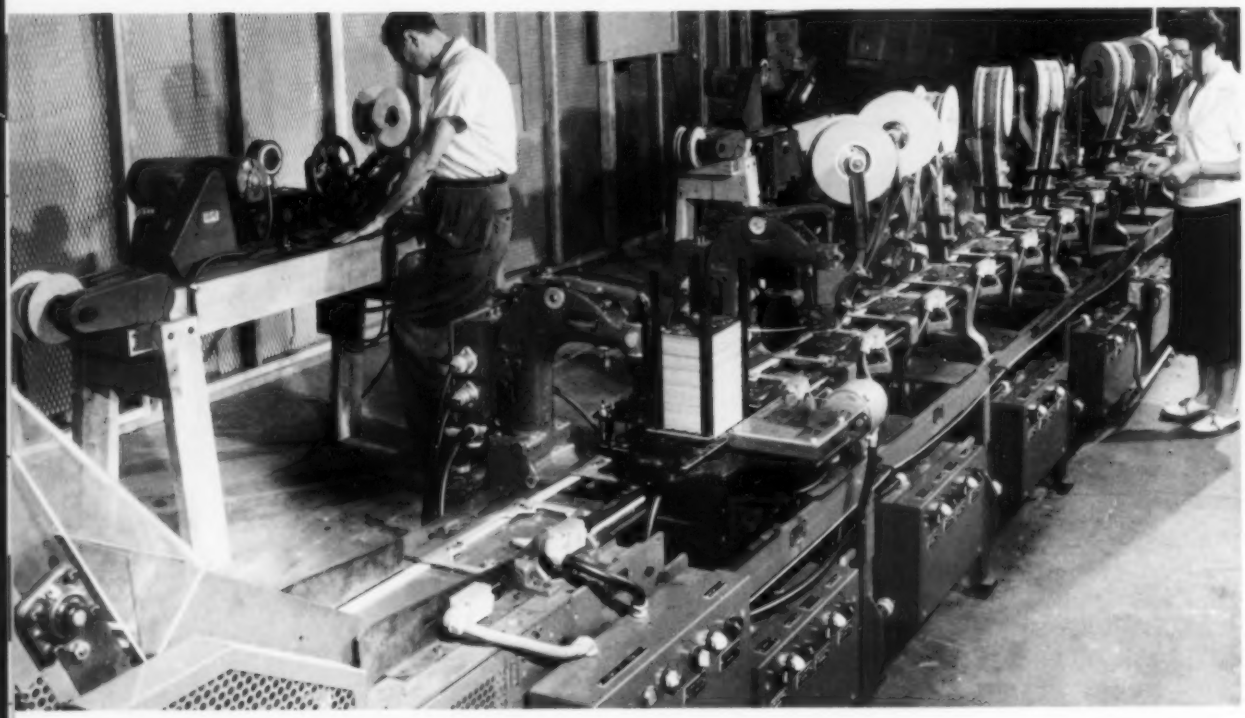
is an important element in designing electronic circuits for automatic assembly, but places demands on design that can be met only by integrating the thinking of several specialists—hence the committee. Conventional point-to-point wiring, left; dip-soldered printed wiring, right. Photos of operations at Emerson by Copper & Brass Research Association.

CONTINUED ON NEXT PAGE

PREPRODUCTION ENGINEERING by committee . . .

An automatic assembly line at Emerson . . .

1, the head end of a 12-station line where printed wiring boards are nested in frames and indexed past individual heads each set up to insert a single component. 2, at the end of the line boards are lifted off, and frames are returned by conveyor to the head end. 3, components in a strip and positioned by tape are fed to the insertion tool where leads are trimmed and formed, component is inserted, and leads crimped from below to hold the part in place.



Problems encountered by the committee are brought up for discussion, and agreement reached, if possible, on the best answer. Whenever the committee cannot reach an immediate decision, the data are recorded. Normally, this takes the form of a Manufacturing request for changes from Engineering. This request for changes is answered to the satisfaction of Manufacturing before being finally disposed of.

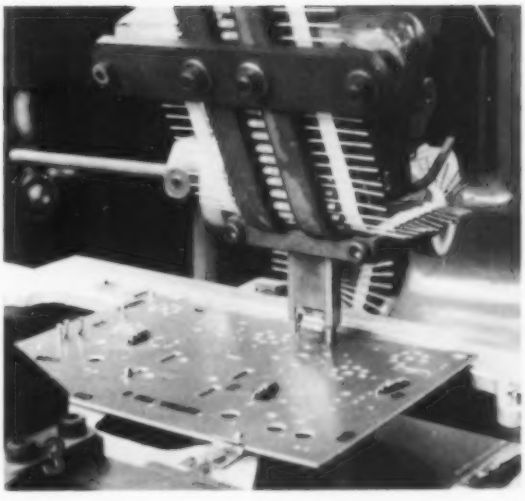
It takes all the points of view represented in this committee to reach objectives of minimum material and labor cost without sacrificing required performance and appearance. Experience with this form of committee operation shows that design engineers tend to work toward specific performance objectives, often overlooking opportunities to eliminate production operations, standardize parts, or use lower-cost components. Production and methods people often come up with proposals that may adversely affect performance, appearance, or tooling costs. Component substitutions aimed at cost reductions may generate other changes that increase costs. The committee is the only way to get all the cost-reducing changes made before releasing the set for production.

The committee operation had conclusively proved its value long before radio and TV sets were built with printed circuits and automatic-assembly components. Decisions faced in automatic manufacture must evaluate a far broader range of problems than for conventional manual assembly. The complexity of these decisions requires combined cooperative judgment based on several varieties of experience: not only mechanical and electrical design, but purchasing, quality control, methods, test, and servicing. Committee evaluation appears to be a logical answer.

Printed wiring and dip soldering, plus automatic assembly of components, are possible ways of reducing labor content, improving uniformity and quality, and reducing manufacturing space needed. These advantages must be weighed against the extra cost of component preparation, pallet or setup cost, overhead cost, and length of time to amortize the equipment.

With manual assembly, it is usual to depend on the operator to pick a part from a random or variable mass, orient it, bend or shape the leads, insert, and clinch and clip the leads. With automatic assembly, the part must be oriented before feeding it to the machine, and the machine has limited ability to handle bent leads or nonuniform parts.

Added manual operations to prepare components for



automatic assembly may introduce more labor than is saved in assembly. Parts requiring tricky methods of orientation may end up with manual insertion a better answer. If some parts require frequent stopping of the entire conveyor to free a jam or replenish the supply of parts, downtime may eat up all potential gain.

Some of the problems of automation are being solved by new component designs, by better packaging, and by improved, more realistic methods and machines. This is a continuously changing process and only a running evaluation can keep up with it. At Emerson, we accomplish this by means of the Manufacturing Engineering Committee which evaluates every radio and TV set based on the experience and knowledge *as of that date.*

Two groups making up the committee are Preproduction Engineering which reports to the production manager, and Design which reports to the director of engineering. Design has the final word on all changes, and is responsible for maintaining performance; but Preproduction has the responsibility for setting up the production line and getting it started. Each group works to get the approval of the other.

Committee evaluation shortens the time required to get cost-saving ideas into operation. It also has a valuable educational function by giving people affected an advance look at problems coming up, and a chance to be heard as well as an opportunity to prepare. Design by Committee has proven its worth at Emerson.

Scientific vs Empirical Design

Warner & Swasey, well-known 67-year-old precision machine-tool builder, may be considered typical both of the machine-tool industry and of highly engineered small-lot manufacture. Hence several things about this company's engineering setup are significant.

One is that, as of January 1, the engineering department was subdivided into design engineering, and research and development engineering. These two will eventually be physically separated; they are already separately administered, although both chief engineers continue to report to Myron Curtis, engineering vice-president.

Here, again, the "team" or "group" plays a significant part; in Mr. Curtis' words, "because the scientific approach has replaced the empirical approach, and modern designs are the product of the thinking of many specialists." The general sales manager, sales manager of a product line, Mr. Curtis and one or two assistants from Engineering, and the manufacturing head make up the team which meets as necessary to consider design changes or new products. Usually, the added style or size is a result of sales requirements, the new product is an outgrowth of engineering work.

This team meets only when it has an agenda; it develops long-term plans, supervises and interprets market surveys, economic reports, and the like. It also studies design layouts as they progress, until the layouts themselves are finalized. Production men may be called in for advice if needed; but final accepance of the layouts is up to Mr. Curtis.

Then a design team takes over. This includes mechanical, hydraulic, electrical and electronic specialists, each contributing his speciality. As design progresses into details, representatives of the manufacturing group—tool engineers, production men, methods and planning men, plus purchasing men—are brought in as needed to advise and criticize, part by part and assembly by assembly. Agreement is reached each step of the way. When the design is done and approved by Mr. Curtis, a manufacturing team takes over.

"BLAST, then refine . . ."

. . . that's Navy for value engineering.

Applied at the New York Naval Shipyard on a trial basis,

it saved millions in the first year.

Here is a summary of what it did — and how.

Rear Admiral Albert G. Mumma, Chief, Bureau of Ships, USN, recently reported to the House Subcommittee on Navy Appropriations that BuShips has established value engineering branches at all eleven U.S. Naval Shipyards. This was a direct result of work of a trial branch at the New York yard, which with a small staff group reporting directly to Admiral Mumma, saved millions of dollars in its first year.

Value engineering, as applied by the Navy, is analyzing shipboard components to get the required function at minimum cost. It is done by a trained value engineer on a product which is already functioning satisfactorily. One technique, called "Blast, then Refine," works this way: Ships have inside lamps for low illumination. The value engineer "blasts" by starting with a cheap commercial counterpart, the plastic household night light. It is obviously inadequate for shipboard conditions, so he refines it as little as possible to make it suitable for shipboard use. Cost is a fraction of that for the original.

Value engineering, or value analysis, was pioneered by General Electric and is spreading rapidly through industry. The Navy invited GE to explain its program in 1954, was so impressed that it immediately established a Value Engineering Office to evaluate these new techniques. The Navy is now in a period of transition to nuclear-powered carriers handling high-performance jets which deliver nuclear weapons. This is extremely costly, so the program is timely.

The first project selected for value engineering was the Landing Craft Program. On the 36-ft LCVP, 25 cost-reduction suggestions were submitted by the value engineers to the design engineers. (The decision to adopt a value-engineering idea must always be the responsibility of the design engineer.) Most of the suggestions were adopted, at an estimated savings of $3000 per boat, a total of more than $3 million. Many of the suggestions can also be used on smaller boats. They include:

1. Changing fuel-tank shape from hard-to-make trapezoid to cylinder, and material from copper to plastic-coated steel. Saving: $460 per boat.

2. Eliminating a hatch and a bulkhead, made unnecessary by the change in fuel tanks.

3. Changing sides and bottom from mahogany to fir plywood, good enough for the short life expectancy of the boat. Saving: $222 per boat.

4. Changing electrical circuit breakers from impact-resistant type to household cartridge type. (Lights are used only in peacetime when impact resistance is not needed.) Saving: $38.50 per boat.

5. Eliminating an exhaust silencer; the exhaust is not the main source of noise.

Save $20 for Every $1 Spent

These savings are insignificant compared to the fact that the study has sparked complete re-analysis of all boats purchased by the Bureau. Also, many other significant savings have been achieved. Examples:

1. Replacing individual electrical-cable hangers with flexible metal packing bands. Saving: $100,000 on one aircraft carrier.

2. Replacing three sizes of stuffing tubes, each of aluminum, brass and steel, with one nylon tube. Saving: $31,584 on one LSD.

3. Replacing an antenna disconnect switch on LCU's by a position added to an existing switch. Saving: $43.20 per boat.

4. Replacing cobalt-coated light bulbs with ordinary bulbs covered by a non-replaceable cobalt lens in front. Saving: $0.32 per bulb.

5. Stapling ground wire to bulkheads of wooden ships instead of attaching by screwed-on clips. Saving: $10,675 per year.

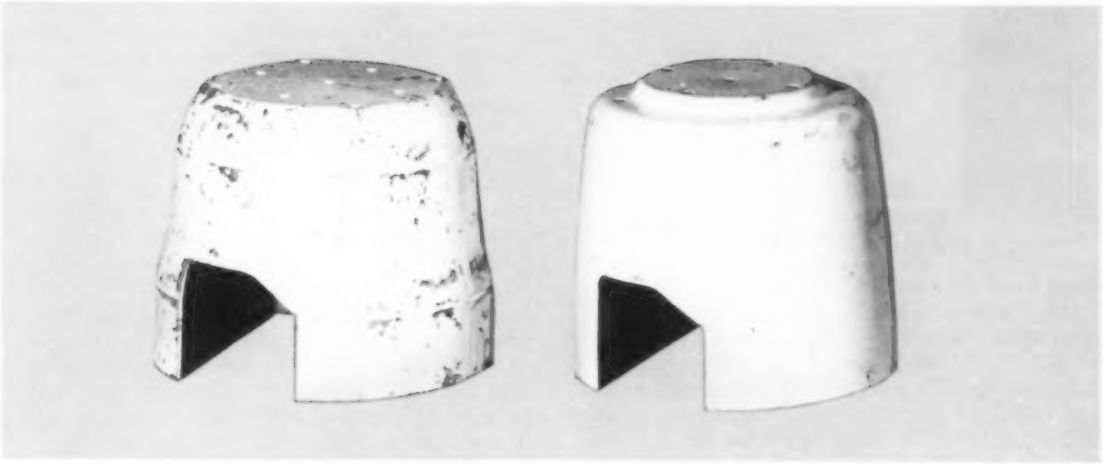
6. Manufacturing ladder tread by roll forming rather than by brake and punch. Saving: $1 per ft of ladder.

7. Deleting the requirement that *all* electrical equipment be radio-interference-free. Currently applied on a selective basis.

8. Deleting the requirement for fungus-proofing electrical insulation. Current insulation is inorganic, hence inherently fungus-proof. Savings are incalculable.

9. Reducing nickel content in salt-water piping from 30 to 10%. Saving: $1½ million annually.

As a result of these successes, the Navy is now developing contracts whereby private shipyards and contractors will employ value-engineering techniques on an incentive basis. A conservative estimate of potential savings is $20 for every dollar spent on value engineering. The first such contract went to Solar Aircraft Company, San Diego, Calif., to value-engineer a small jet engine it makes for the Navy.



Evaluation by Comparison Cut Cost 40%

This housing, about 8½ in. dia and 7 in. deep, started out as a diecasting, left. The form suggested a cooking pan which is usually made as a deep-drawn stamping. By changing to this process the cost was reduced from $1.02 as an aluminum diecasting to only 60¢ as a steel stamping — $31,500 annual saving.

VALUE CONTROL . . .

Extension of value analysis

Systematic method developed by General Electric constantly evaluates parts, processes and services in terms of dollar value — first at the design level and then in production and purchasing.

L. D. MILES, manager, Value Analysis, GENERAL ELECTRIC COMPANY

The "value" of a part or product is the lowest cost to reliably accomplish its function. "Value Analysis" is a package of techniques and practices for establishing value and improving it by providing more facts for the basis of decisions to improve value. This is accomplished by systems of comparisons: Determining facts of design, manufacturing, cost, use, etc.; facing up to exact functions; searching for lowest cost means; and relating functions to each other in reference to need. An effective approach is through these questions:

What is the item?
What does it really do?
What does it cost?
What else will accomplish the needed function?
What will that cost?

At this evaluation stage there are some very persistent design factors that must be excluded or a warped evaluation results; such as:

Make it as similar items have been made
Design it onto the machines we have
Use elements and components we already have
Make it rather than buy

While these factors are vital and are evaluated when the time for decision arrives, if allowed to limit evalua-

CONTINUED ON NEXT PAGE

VALUE CONTROL . . .

Extension of value analysis

tions they will produce falsely high "apparent" dollar values which competition will expose.

This evaluation process is applied to the selection of each factor which increases cost. On an extra close tolerance, for example: How much does it cost, what alternative would accomplish the same purpose, and what would that cost. Or a special material: How much does it cost, what else would accomplish its use equally well, and what would that cost.

Analysis of value extends to whatever item costs money: processes, services and ideas as well as parts and assemblies. To promote effective evaluation a package of techniques are used:

1. **Effective creative thinking.**
2. **Evaluate by comparison.**
3. **Blast – then refine**
4. **Identify and overcome specific roadblocks.**

All are used throughout the various appropriate steps in the technique.

Creative thinking or brainstorming, adequately described in other literature.

Comparison which requires skill in selecting the most fruitful comparisons.

Blast – then refine, a technique of accepting a function and a means for accomplishing it, then denying oneself the use of this means and starting again mentally from simple low cost materials or processes which will not entirely accomplish the function. Then refine by adding and improving until the function is fully accomplished.

Identifying roadblocks or locating and focusing sharply on the exact situation or information (or lack of information) which causes the product to be made as it is now made or intended.

What is Value Control?

Consider the parallel field of quality control, where it was first necessary through quality analysis to develop a body of information, techniques and skills. Thereafter, using the results of quality analysis, it became practical to provide a system of quality control.

So it is with Value Control. Through several years of intense analysis and study of value – value analysis – learning how it is measured, how it is secured, how it is lost, how it is increased, and how it is decreased, a system of control becomes practical. Such a system of Value Control includes three phases:

Phase 1. In preparation for specific problems, provide engineering and drafting people with specific information establishing value of components, parts and functions as general reference data.

Phase 2. Establish value figures (not cost figures) for specific parts or components or functions for immediate use on the design project at hand.

Phase 3. Maintain a continuing evaluation service for existing products which periodically reviews the value of parts, components, and functions and suggests specific avenues of profitable redesign.

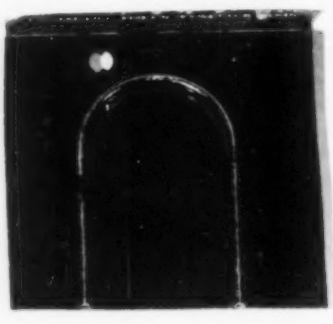
Using the value analysis techniques in these three phases, the Value Control function is performed by full-time engineers called Professional Value Specialists, with specialized training which includes:

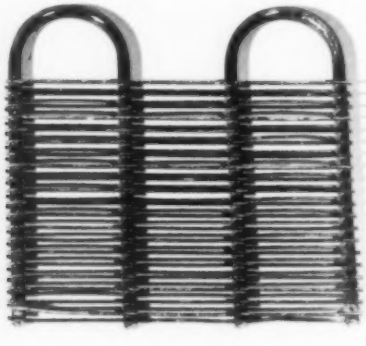
Knowledge of many hundred special products, processes, and materials available within and outside the company.

Acquaintance with leading specialists in material and process development in laboratories both within the company and at suppliers.

Blast and Refine Developed New Approach

This refrigerator condenser, left, was a metal plate with coils of tubing welded on. In years of cost reducing it had been progressively changed from costly welded double plates of stainless to this form with no loss in performance. Then, the engineering manager said "It's got to be half the weight, half the cost, same efficiency." Adapting and improving skills used in fence manufacture, the tubes were welded to parallel wires. Result: half the weight, almost half the cost, and better performance.





Identify and Overcome Roadblocks — Saved $50,000 a year

This little1/16in. dia pin was being purchased, 50 million a year, for $3 per 1000. Value was questioned by the Value Specialist. Material was only 25¢ per 1000; with mass production how did it get up to $3? Some fact finding developed that stock used was oversize and had to be ground to size. Also, improper inspection was rejecting usable parts. Price dropped to $2 per 1000, the same vendor still makes a fair profit, and we save $50,000 a year.

Experience with value analysis techniques.

It is their assignment to organize and carry out the training for phase 1 and do the actual work in phases 2 and 3.

Value Control operates both in the study of existing products and in the design of new products. It is important to the designer of the product because these professional value specialists draw upon such an enormous potential of experience. They can supply specialized information on markets, materials, and standard or specialized parts or processes. They can also bring to bear the engineering skill and ingenuity of specialty suppliers.

Practical, effective approach

Value Control is not the same as cost reduction. It is a new science, which produces experience vastly different from the past. It calls for a wide-open mind and the use of much more information at the point of decision-making. With Value Control and minds unhampered by past thinking, the same technical skills are now delivering the same performance for very much lower cost.

How do I start?

First, recognize that regardless of my engineering skill, persistence and determination, I as a lone engineer can have before me at the time of my decision only a small proportion of the vast amount of available information and numbers of good applicable ideas. Therefore, I will:

Invite qualified people to apply their knowledge, ingenuity and skills to my area.

Expand my reading and scanning of technical literature not only in my own field but in related fields.

Use the techniques of Value Control – creative thinking, evaluate by comparison, blast then refine, and eliminate roadblocks.

This One Involved All Techniques

This screw-machine spacer holds parts together, spaces them, and former design, top, cost 8¢. Comparison: It's like a thick-headed screw worth about 2¢; it's partly like a nail with rolled threads, worth about ½¢. Blast and Refine: It's partly like a piece of wire with rolled grooves, worth ¼ to ½¢; it's like a nail with two heads and rolled threads — if they could make it — worth about 2¢. Scanning Trade Literature: many companies do specialty cold heading and rolled threads. Using Qualified Experts (vendors): Two could not do it; a third one produced the part shown at right at a cost of 1¢ instead of 8¢.

Now Try It on This One!

The examples shown here look so easy, now that we have the answers. Let's take the refrigerator condenser: how about keeping performance constant and remove half the cost again. We are panicked. "It can't be done; it's only wire and tubing." But it can be done and will be done; the only unknowns are when and who. How would you do it?

Design for Producibility

Boeing's Wichita (Kan.) division reports "more harmony than a barber-shop quartet" as a result of a share-the-experience program. Aimed directly at providing design engineers with up-to-date knowledge of shop methods and capacities, it has some of the elements of value engineering, some of an extra-special liaison system, some of training. About 650 engineers are involved.

In its early days, the system resulted in redesign of a B-47 drop-tank bulkhead casting so it replaced about 40 parts. Later, a spoiler support casting for the B-52 caused too many rejections in assembly. The engineers found that a more practical dimensioning approach was in order. When the vendor reviewed the new drawing, he estimated that cost could be cut from $72.50 to $32.50. Actually, gains were greater; on a later order for 144 assemblies, cost was only $9.47 each.

The program has two major phases. One is to give design engineers continuous "on-shift" training, the other to provide them with a "consultant" service in design for production. Four instructors handle training, developing material and presenting two lectures a day. Each engineer attends once each three weeks. Covered are casting and forging processes, dimensioning and toleranicing, metal bonding, etc., and new processes as they develop. Shop tours, technical films, and movies of Wichita facilities are included. Each lecture emphasizes local facilities and capacities, current manufacturing methods, and the like, to keep engineers up on the background of a "producible" design. Among 300 engineers, after 30 sessions of the program, 99% felt the training had been of value.

For the consulting-service part of the program, eleven technicians and specialists act as advisers to the designers. Six came from key shop positions; they answer questions, provide cost comparisons, offer guidance, suggest design improvements, dig into design problems. The other five men are engineers with special assignments in casting design, forgings and extrusions, design manual and specification coordination, and over-all design-manufacturing problems.

The group studies new processes, provides specification data, and serves vendors and subcontractors as well.

Background Reading

Functions of the Design Committee and problems in planning, conducting and coordinating product development have been receiving increased editorial attention. While not an all-inclusive list, the following articles in recent issues offer additional background for the management of product development.

The Administrative Engineer Can Help, April 1957 page 190. How the administrative engineer can function as a coordinator of research, design and management in supplying planning and control, and interpreting technical matters in non-technical terms.

Project Group vs Service Group in Engineering Development, August 1956 page 198. Contrast of two methods; influence of size of company, type of management, and significance of morale. Enthusiastic leadership is held to be the key element.

Engineering Problems in Continuous Automated Production, Design Digest, Mid-October 1955 page A21. Automation as it affects design engineering is treated as a way of designing operations out of manufacture. Three types of processes, and requirements determining choice. Includes abstracts from 17 articles and technical papers.

Product Development—The Project Engineer's Place, December 1955 page 189. Inclusive chart of steps in product development to guide in conducting an effective project; function of the administrator.

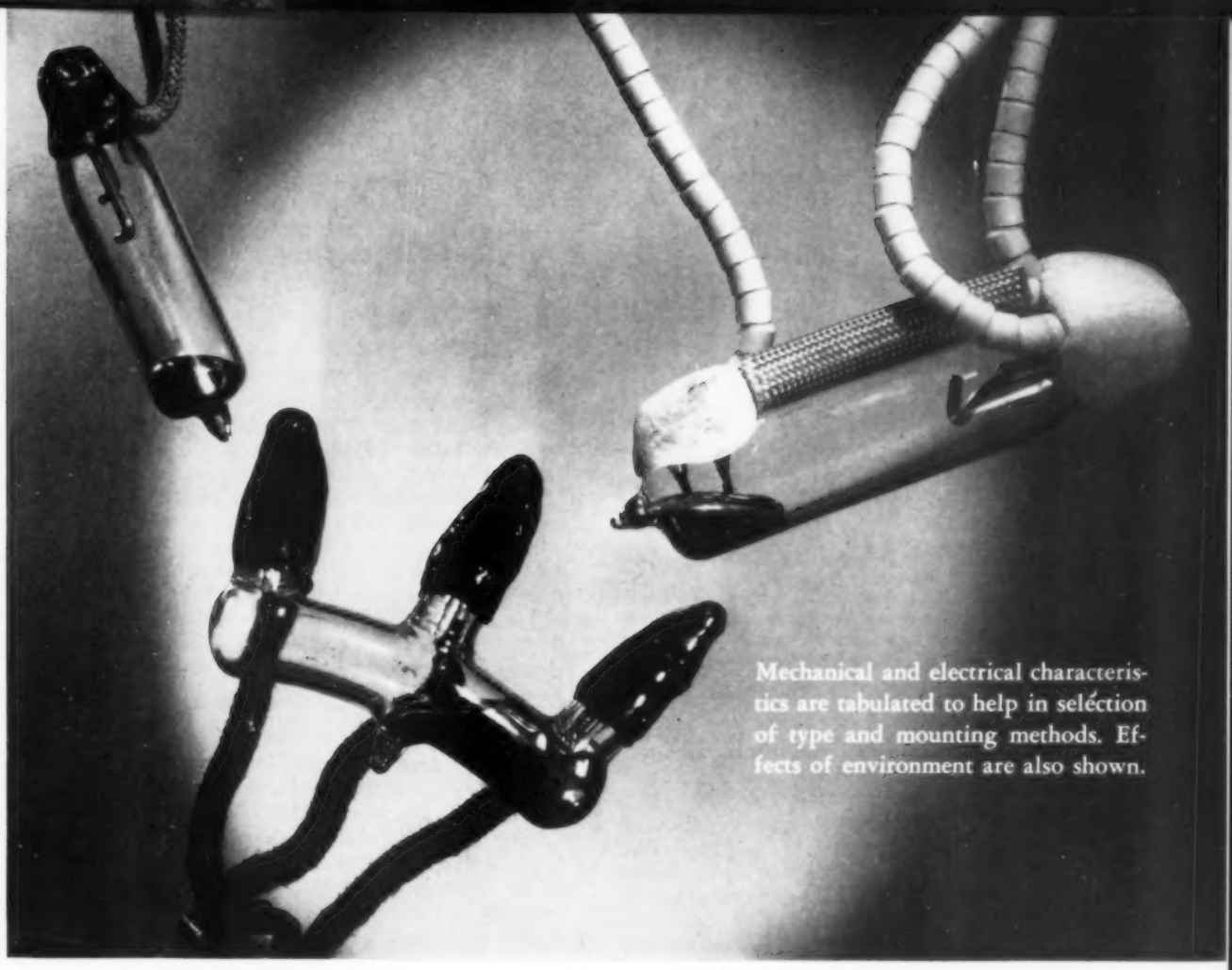
Product Development—A Running Start, September 1955 page 179. Why a well organized product planning committee is indispensable; membership of the committee, types of projects it can handle, how it functions.

Break-Even Charts Tell You If A Product Should Be Made, Design Digest, Mid-October 1954 page A25. How to determine profit and break-even point; aid in selecting alternative manufacturing methods; extent of mechanization.

Control of Cost of Research and Development Projects, Design Digest, Mid-October 1954 page A9. Methods applicable to applied research and development; use of commercial laboratory facilities and research institutes; general requirements of a project plan.

Product Development Conference, October 1955 page 129. Excerpts from a 3-hr recorded conference of the management committee responsible for product development at Yale & Towne. Solving communication problems; function of a coordinating engineer, and need for effective cooperation between specialist groups.

Insuring Your Progress Through Research, June 1953 page 171. A 32-page special report covering management problems in organizing for product development: obtaining and keeping research personnel; policy in administering design in the laboratory; evaluating research projects; setting up research budgets; patent licensing policy and procedures; role of independent research facilities; using government research data. (A limited number of reprints of this special report are now available, and single copies will be supplied without charge on requests made on company letterhead.)



Mechanical and electrical characteristics are tabulated to help in selection of type and mounting methods. Effects of environment are also shown.

Where and When to Apply Tilt-Type MERCURY SWITCHES

WARNER E. JOHNSON, *Micro Switch Division, Minneapolis-Honeywell Regulator Co.*

USUAL methods of making or breaking an electrical circuit—relays, push-buttons and mechanical switches—have limitations when environment involves dust, moisture, spray or splashing liquids, or where actuating motion is a slow, limited rotation with low forces available. In such applications, tilt-type mercury switches may be the best answer.

These switches are glass or metal tubes into which stationary electrodes and a pool of loose mercury are sealed. Tilting the tube causes the mercury to flow in a direction to open or close a gap between the electrodes, to thus make or break the contact. Because the switch is sealed, no contact deterioration is caused by pitting or corrosion. The primary factor limiting switch life is the flexible leads through which contact connections are made; when properly applied, the switches are good for several million operations.

Three types of electrodes are used, the mercury-to-"dry"-metal, mercury-to-"wet"-metal, and mercury-to-mercury. **Mercury-to-dry-metal** contacts are used for low-cost switches which carry loads limited to a few amperes. Arcing is minimized by using mercury of high purity which breaks rapidly from the electrodes when the switch is tilted to OFF.

Mercury-to-wet-metal contact provides a low-resistance contact. In addition, closure or separation of such a contact provides an inherently rapid make or break under slow actuating motion.

Fig. 1—Heavy-duty mercury switch handles steady currents up to 45 amp and inrush currents of 144 amp. The metal electrodes remain submerged in mercury while contact is made or broken by joining or dividing the pool of mercury. A ceramic sleeve protects the glass from the arc which occurs when heavy currents are initiated or interrupted.

Mercury-to-mercury contacts are used for heavy-duty loads. The metal electrodes remain submerged in mercury and the actual make and break is obtained by joining or separating the mercury between the (usually two) contacts. Arcing on the joining or separation of mercury has a destructive effect on the glass and can reduce switch life. For high current ratings, an internal ceramic sleeve is inserted in the tube, and contact making and breaking occurs inside this protective barrier, Fig. 1. A comparison of typical switch types and type of electrodes with which they are used appears in Table I.

Contact Arrangements

Most mercury switches are constructed with either one or two pairs of electrodes or contacts. For a single pair, the switch can be used as a single-pole, single-throw devices shown at the top of Fig. 2. In one type, the switch is closed by tilting the switch up, in the other by tilting it down. Where the switch has two electrodes in each end, it can be used to close two independent circuits, as in middle of Fig. 2; but only one can be closed at a time. By connecting two of the terminals as shown at the bottom, this switch can be used as a single-pole double-throw device.

For more specialized applications, other combinations of electrodes and operating functions are available.

TABLE I—TYPICAL MERCURY-SWITCH TYPES AND ELECTRODES USED

Switch Type	Type of Electrodes		
	Dry	Wet	Mercury
Single-pole, single-throw (SPST)	X	X	X
Single-pole, double-throw (SPDT)	X	X	X
Double-pole alternate-throw	X		X
Three-pole, single-throw	X	X	

Operating Angle

Because these switches are operated by a tilting motion, the method of mounting and desired angle of tilt are significant. In applications where the switch closes a circuit when the lid is lifted, such as in appliances, the switch can be mounted in standard spring clips and fastened to the moving section.

Tilt of differential angle is the minimum angle required to produce switching action. In two-contact, single-pole switches (Fig. 2) this is the angular motion between the position at which contact is initiated and the position at which it is broken. In the four-contact or two-circuit switch, it is angular difference between the positions at which contact closure is initiated on one end and then the other. Minimum operating angles are given in Table II.

Actuating Speed

Current-interrupting capacity is influenced by operating speed. Where the tilting action is slow, such as with bimetal strips or thermal bellows, a switch listed for slow operation should be chosen. Where motion is provided by rapidly moving elements, those listed for fast operation should be applied. Unstable circuit operation may result, if a switch designed for fast actuation is tilted at a slow rate.

Mounting Methods

Type of application, shape of the actuating member, and the motion produced by it, determine method of mounting a mercury switch. In some cases the switch can be mounted directly, such as in appliance lids; in other cases an actuator and linkage must be used; or it may be necessary to devise a tilt-method for the application. Six examples of mounting are shown in Fig. 4.

Ample overtravel is desirable. One method is to incorporate "slack" or free motion, which is effective with the above-center mounting, (E) in Fig. 4. The added looseness allows the switch to introduce a small drop to either the OFF or ON position, which aids in producing chatter-free switching, just as overtravel in leaf-type switches increases contact forces and produces positive switching action.

Although mercury switches are sealed devices they are not classified by Underwriters as explosion-proof. For hazardous atmospheres, special enclosures and mountings may be required.

In all types of mounting, it is necessary to incorporate some method for adjusting the "at rest' or initial position of the switch to provide the contact action desired. Various mechanical arrangements can be used, and for applications where timing is critical some means of setting the switch may be required as an integral part of the equipment using the switch.

Where actuating forces are low, leads must be ar-

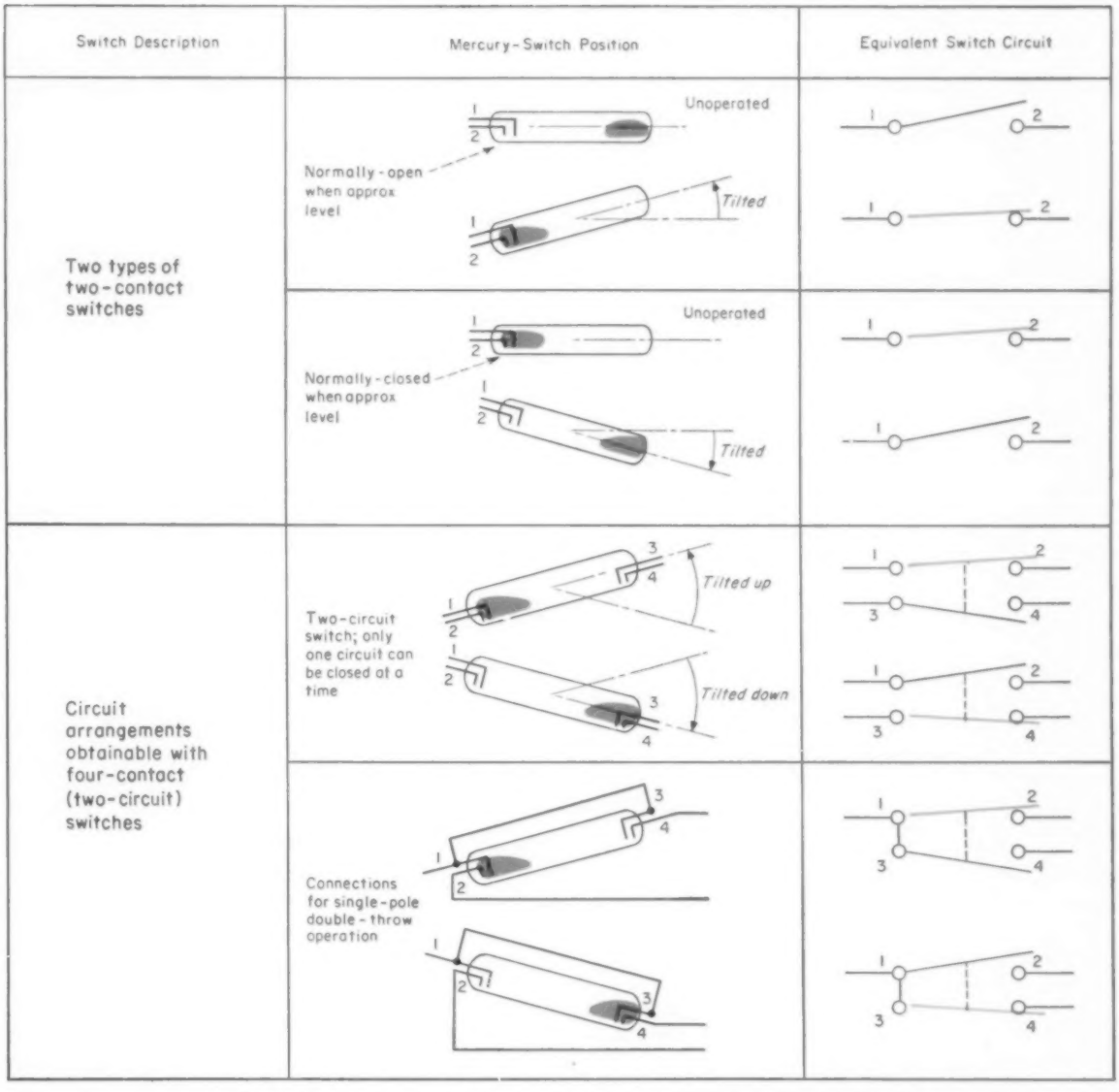


Fig. 2—Typical mercury-switch operation for single-ended and double-ended units. The equivalent switch circuit is drawn in terms of conventional switch diagrams. The two-circuit switch operates like a double-pole switch with mechanically interlocked arms, because either circuit can be closed, but not both at the same time.

ranged to produce minimum tension opposing switch operation. Useful switch life can be increased by minimizing bending or twisting stress on leads. Normal lead insulation is cotton, but for moist or wet locations plastic-coated wire is used. Typical lead length is 7 or 8 in. For large angles of tilt, lead length should be increased.

Effect of Environment

Mercury switches are not normally suitable for immersion. Also, certain types of chemical dusts, oil spray or other corrosive agents may react with the lead cement or the glass. For unusual environmental conditions it is advisable to check with the manufacturer. Switches subject to damage from adverse ambient conditions,

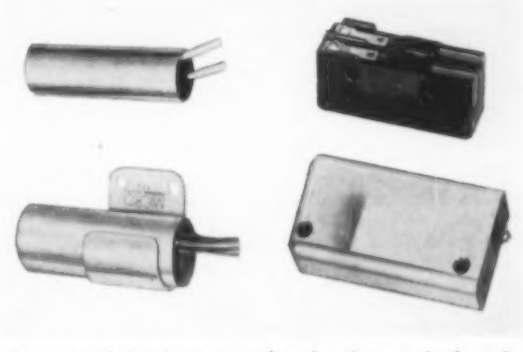


Fig. 3—Switches are protected against impact, shock, and adverse ambient conditions by encapsulation.

TABLE II—MECHANICAL AND ELECTRICAL CHARACTERISTICS OF TYPICAL MERCURY SWITCHES

Type of Duty	Contact Arrangement	Operating Angle, deg	Type Voltage	Current Rating, amp					
				Inrush, Inductive		Constant			
						Inductive		Resistive	
				115v	230v	115v	230v	115v	230v
Light	SPST	5	a-c, d-c	.....	.....	1	0.5	1	0.5
		12	a-c	.....	.....	1	0.5	1	0.5
			d-c	.....	.....	0.5	0.25	0.5	0.25
			a-c, d-c	.....	.....	0.75	.....	0.75	.....
Medium	SPST	9	a-c	.....	.....	1.8	0.9	3	1.5
			d-c	.....	.....	0.65	0.35	3	1.5
		10							
		3	a-c	44.4	30.6	7.4	5.1	10	5
			d-c	24	12	2.4	1.2	5	2
		5							
	SPDT or Two Circuit	7	a-c	13.2	6.6	2.2	1.1	5	2.5
			d-c	11	5.5	1.1	0.55	5	2.5
Heavy	SPST	5	a-c	144	72	24	12	45	35
			d-c	126	82	12.6	8.2	45	35
		6.5	a-c	110	72	18.4	12	25	20
			d-c	86	63	8.6	6.3	25	20
Small-angle operation	SPST	0.5	a-c, d-c	.....	.....	1	0.5	2	1
	Two Circuit	1.2							
	SPST	0.25	250 milliamp at 30v a-c						
	SPDT	1							

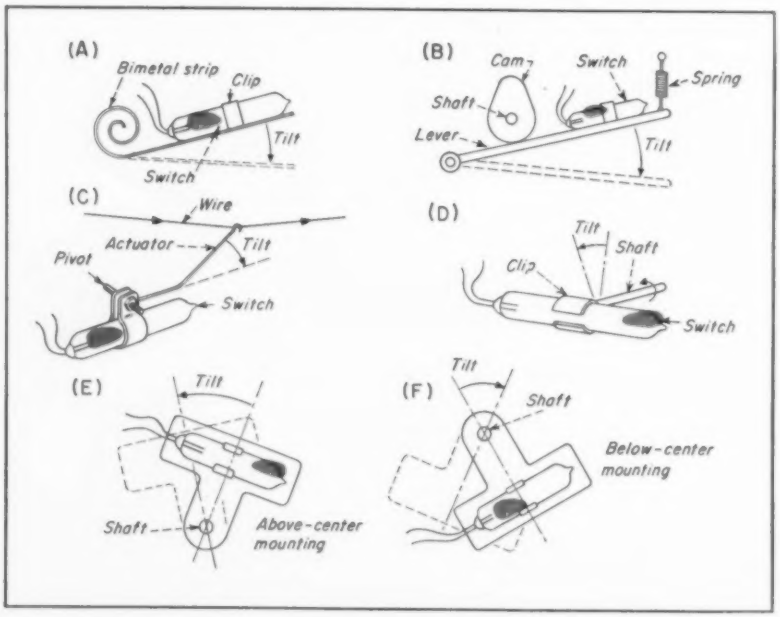


Fig. 4—Six methods of mounting and actuating mercury switches. (A) For temperature-control, the switch may be mounted on a bimetal strip, the angle varying with temperature. Here, the switch is in the actuated position with contacts closed. (B) Output of a cam actuates switch mounted on cam-driven lever. (C) Pivoted actuator used to detect wire break. When the wire parts, actuator arm drops and tilts switch, interrupting current to wire-reel motor. (D) Limited rotation of shaft tilts switch in clip mounted on shaft end; advantages of this mounting are simplicity and small space used. (E) For fast contact action, above-center mounting is recommended; it is the generally preferred type of mounting. (F) For minimum operating force, below-center mounting is recommended.

TABLE II—MECHANICAL AND ELECTRICAL CHARACTERISTICS OF TYPICAL MERCURY SWITCHES (continued)

Actuating Speed	Approx Dimensions, in.		Typical Control Applications
	Length	Diameter	
Slow or fast	1-1/2	3/8	Control and indicating devices, animated displays, appliances, foot switches, business machines
Fast	1-3/4		
Slow or fast	2	7/16	Small heaters, lamps, solenoids, motors
Fast	2-1/4	5/8	Up to 1/2-hp motors, medium lamp loads, high-current-inrush solenoids
Slow	2-7/8		
	2-1/2		
	3	9/16	Two independent SP circuits; can also be connected as SPDT switch
Slow or fast	2-5/16	11/16	Up to 2-hp motor; devices with inrush currents up to 144 amp.
	2-3/4		
Slow	2-3/16	1/2	Thermostats and automatic-leveling devices
Slow or fast	1-13/16		
Slow	1-1/16	13/32	
	1-3/16		

shock, or vibration, can be protected by embedding in wax or plastic in metal or phenolic cases, Fig. 3. These enclosures may also simplify mounting.

Minimum temperature at which typical switches can be applied is −35 F, slightly above the freezing point of mercury. Use of a special mercury-thallium amalgum permits operation to −65 F. Usual maximum is 160 F, but some types are designed to operate to 300 F.

In general, applications involving vibration are not recommended for mercury switches. However, where vibration is not severe, the tilt action may be designed for sufficient overtravel to flood the contacts and prevent intermittent contact or false interruption.

Where the switch is subject to intermittent or continuous impact or shock, splashing of the mercury will interrupt the circuit. Severe impact may break the tube.

Electrical Characteristics

Current and voltage ratings for mercury tilt-switches used for light, medium, or heavy-duty applications are given in Table II. These switches must be protected against short-circuit currents by fuses; high peak currents can vaporize the mercury and produce gas pressure in the glass tube. Under short-circuit conditions the pressure may be enough to rupture the glass. Fuse ratings should not exceed maximum current and voltage ratings for the switch.

While minimum voltage shown in Table II is 115, all switches listed can be used at lower voltages. At 20 or 32 volts and with a constant-current resistive load, current ratings may be increased by about one-half for most of the switches.

EDITOR'S NOTE: Articles dealing with other types of mercury switches: "Mercury Plunger Relays", March 1956 page 182, discussed relays in which mercury is displaced to make a contact by means of a magnetic core drawn down into a pool of mercury by solenoid action. Applications and ratings are for motors and other industrial controls. "Mercury Jet Switch", October 1955 page 185, described operation and electrical characteristics of a switch using a rotating jet of mercury for a contact; principle use is in sequential switching of multiple circuits, such as in telemetering.

Small Parts Assembly Simplified with . . .

SINGLE-COMPONENT EPOXY ADHESIVE

BERNARD GOULD
Rubber and Asbestos Corporation
Bloomfield, N. J.

Paste adhesive developed for non-aircraft use has moderate tensile shear strength to 250 F, retains form during curing, requires no hardener.

EPOXY adhesives have been used for joining metal and non-metal parts since 1948, particularly in the aircraft industry. Epoxies originated as multiple-component adhesives, that is, partially polymerized monomers in paste or liquid form requiring addition of a second component or curing agent to complete the reaction. Many such multiple-component industrial adhesives are available with good strength over a broad temperature range; some have been successfully used for almost 10 years.

This multiple-component character of epoxy-resin adhesives is the major obstacle to wider industrial use. Fresh components must be carefully weighed and mixed just prior to application to insure consistent strength, thus creating production, inventory and wastage, problems. But epoxy adhesives have often been the only solution to some fastening requirements; for example, bonded aircraft honeycomb structures requiring long-time elevated-temperature strength.

A single-component, 100%-solids epoxy overcoming many of these difficulties has now been developed. Based on field tests over the past year, this adhesive (designated M620) has these characteristics:

1. Curing agent is not required; adhesive may be applied directly. Consistency is that of soft butter, permitting application by spatula, brush or roller, with a minimum of clean-up.

2. Adhesive is thixotropic, that is, it gels slightly

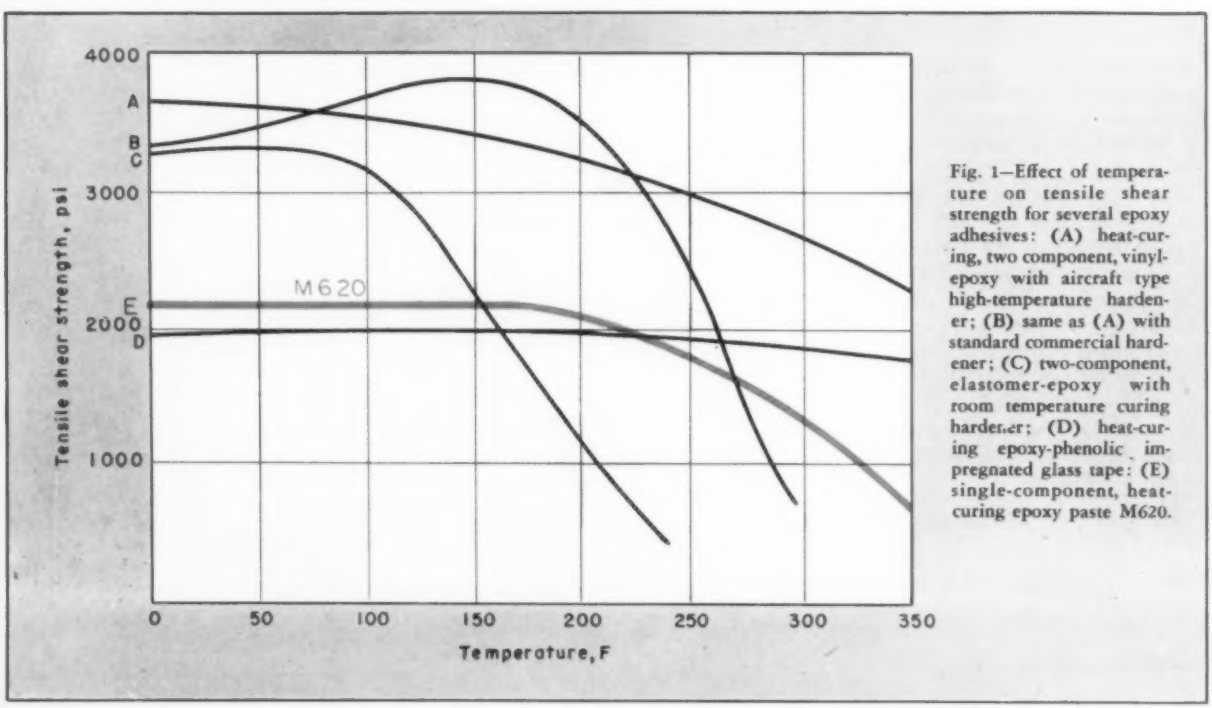
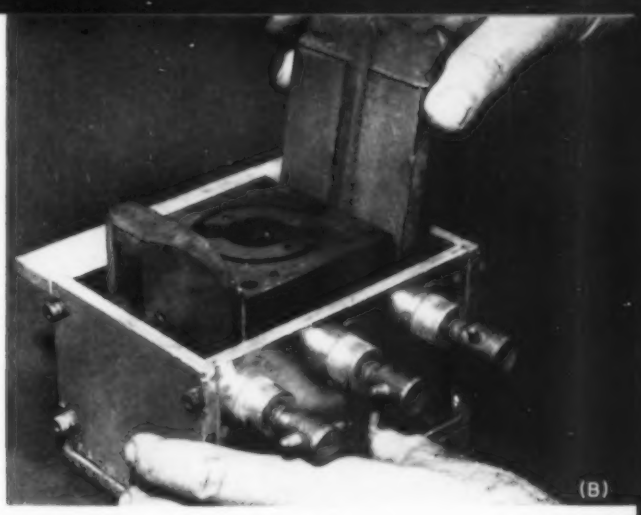


Fig. 1—Effect of temperature on tensile shear strength for several epoxy adhesives: (A) heat-curing, two component, vinyl-epoxy with aircraft type high-temperature hardener; (B) same as (A) with standard commercial hardener; (C) two-component, elastomer-epoxy with room temperature curing hardener; (D) heat-curing epoxy-phenolic impregnated glass tape: (E) single-component, heat-curing epoxy paste M620.



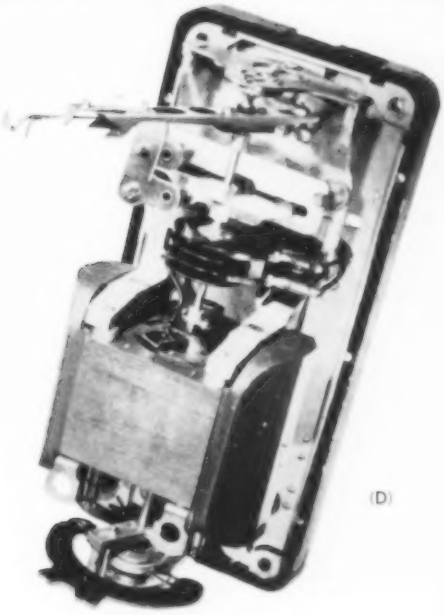


Fig. 2—Alnico permanent magnets are joined to laminated-steel core with single-component epoxy adhesive in new Westinghouse recording d-c watt-meter. Adhesive is applied as-received to parts with rubber roller (A); magnets are aligned with core in simple fixture (B) and held in place by hand screws; thixotropic additive prevents adhesive run-off during 50-min cure at 400 F (C); bonded unit is assembled with moving parts on meter frame (D). Principal advantages of method are consistent quality of product, economy, and no thermal damage to magnets.

when applied, maintaining its form and position during the curing cycle. Adhesive thickness can thus be closely controlled where loosely fit parts are joined.

3. **Contact pressures are low,** in the order of 5-15 psi, simplifying fixture design.

TABLE I—ALTERNATE CURING CYCLES

Temperature in Bonding Layer, F	Minimum Curing Time
535	7 to 10 min.
500	12 to 15 min.
450	20 to 25 min.
400	40 to 50 min.
350	1½ to 2 hr.
300	4 to 5 hr.
260	20 to 24 hr.

4. **Curing cycle can be varied,** depending upon temperature the assembly can tolerate and the curing time required. Alternate curing cycles are shown in Table I.

5. **Tensile shear strength** is about 60% that of the best multiple-component aircraft adhesives, Fig. 1. Strength above 2000 psi is maintained to 200 F, with no sharp fall-off.

6. **Process is simpler than brazing or soldering,** Fig. 2, reducing influence of the human factor.

7. **Storage life** is over 1 year.

Tensile Shear vs Block Shear

Ability to resist forces in shear gives adhesives their value as fasteners. Energy absorption of epoxy adhesives in pure tension is poor; hence loadings which tend to peel the joint apart are undesirable. Tensile shear tests, such as those shown in Fig. 1, use a single lap joint of two thin metal strips. Eccentric loading inherent in this test, plus flexibility of the joined

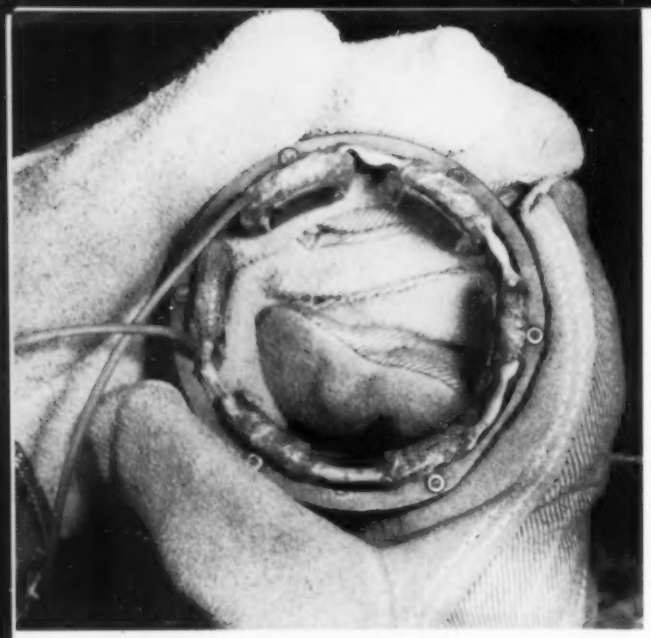


Fig. 3—Stator for jet-aircraft alternator has coil connections insulated with single-component epoxy adhesive, cured in 90 min at 350 F. Adhesive holds shape and bonds with silicon tape on coils at 400 F operating temperature. Stator built by R. E. Phelon Co., Long Meadows, Mass.

Fig. 4—Magnets in zinc die-cast undercarriage for Lionel model electric train. Magnets are fastened by single-component epoxy. Note loose fit for thick layer of thixotropic adhesive which is retained during cure at 300 F.

strips, produces peeling loads at the lap edges and lowers joint strength. Block shear tests, using double lap joints with rigid members to eliminate peeling action, yield substantially higher shear strengths. For example, M620 has a block shear strength at room temperature of 3400 psi, compared to a tensile shear value of 2200 psi. This difference is important in evaluating adhesive specifications and in selecting adhesives for a particular loading arrangement.

Applications

High peel strength is not required in many industrial applications. Parts may be held in position under both static and vibratory conditions which impose essentially pure shear on the joint. In these cases, a careful comparison of adhesive joining with metallurgical joining should be made to optimize production costs and product quality. Three such examples are shown in Figs. 2-4; sequence of Fig. 2 shows simplicity of process with single-component epoxy paste.

EDITOR'S NOTE: Other articles of interest on chemical fastening include:

"Joint Design for Adhesive Bonding", Mid-October 1956 page G10. Defines basic factors in good adhesive joint design, with adhesive selection table for various adherend combinations.

"Adhesive-Bonded Metal Joints," July 1955 page 170. Room temperature tensile shear strengths of eight adhesives, including rigid types plastic rubber-resin compounds. Effect of loading rate discussed.

"Adhesive Bonding", May 1955 page 181, discusses proper approach to selection and specification of correct formulation and process, including designer's checklist.

"Metal-to-Metal Bonding With Epoxy Resin-Based Adhesives," July 1954 page 166. Bond characteristics, strength under static and impact loading and application factors that simplify assembly of sheet metal structures.

Ceramic Adhesives for Elevated Temperatures

RECENT RESEARCH on ceramic adhesives for stainless steels at elevated temperatures indicates that a ceramic-oxide, glossy bond frit will give tensile shear strengths in the order of 2500-3500 psi at 800 F if properly formulated.

Ceramic adhesives of the "air-setting" silicate type will give a tensile shear strength of about 1000 psi at 1000 F; however, due to the nature of the bonds developed, their moisture resistance is low. Exposure to boiling water or even saturated air at 100 F greatly decreases bond strength. Oxychloride and oxysulfide commercial adhesives will develop nominal strengths of 200-250 psi at room temperature up to 600 F. One commercial air setting cement shows promise of meeting the target of 1000 psi at 1000 F for 1000 hr with a subsequent cure to 600 F.

Cermet-type adhesives, prepared by mixing 5 to 50% finely ground metallic cobalt and chromium with a lead borosilicate glass matrix, do not show as much promise as expected. However, a 30% metallic cobalt mixture shows considerable promise if adherend wetting techniques can be improved.

Report on this research at the University of Illinois is OTS paper PB 121659 available from the U. S. Dept. of Commerce, Washington D. C., price $2.50.

HYDRAULIC CONTROL VALVES

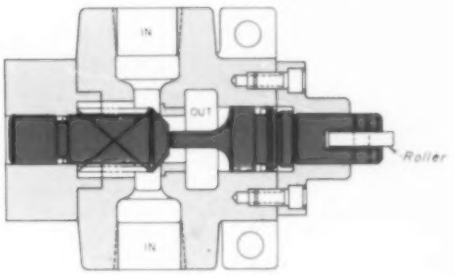


Fig. 1—A cam operated two-way valve with two manifolded input ports and one output port.

IV. Directional Valves

Four-way valve spool design and typical circuit applications when ports are blocked, open, throttled or variously interconnected in the neutral position.

JOHN J. PIPPENGER
Double A Products Co., Manchester, Michigan

THE TERMS TWO-WAY, three-way, four-way or diversion valve indicate the function that is expected from a component. A two-way valve is expected to either block or permit free flow from one port to another or from one group of ports to another group of ports. A two-way valve may have a plurality of ports as shown in Fig. 1. A two-way valve with two input ports may be inserted in a pipe line to permit through flow. When the spool is shifted it will connect the two common ports to a third port.

Three-way valves add another function to these units. Porting in a three-way valve includes a pressure port, one cylinder port and a tank port. Again, the three-way valve often has additional porting that is merely a convenience in the plumbing or for gage connections. Pressure port to cylinder port connection is similar to the two-way valve function, either open or closed. Cylinder and tank ports are also similar to two-way valve function in that they are either open or closed as the valve is shifted from one extreme position to the other.

When pressure is directed to cylinder port, tank port is blocked. The opposite shift of the valve connects cylinder port with tank port and pressure port is blocked. This three-way operation is most commonly used as directional control valve with gravity return rams, spring loaded cylinders or gage checking stations.

Diversion valves are sometimes constructed with three ports and designated three-way diversion valves. In this unit the pressure port is directed to one port while the second port is blocked and vice versa. Three-way diversion valves are often of the open center type.

Four-way valves usually have four ports though there are a large number manufactured with five ports. A five port two-pressure valve is shown in Fig. 2. Basic operation is usually the diversion of pressure to one cylinder port in an extreme shifted position with the fluid returning from the other end of the cylinder and directed through the valve to a tank port. This function is reversed in the opposite extreme position of the valve. Neutral position flow will vary as explained below. The four-way valve may also be used as a double two-way valve. In this kind of operation, the unit would be shifted from neutral position to one extreme position. In neutral position all flows are stopped. In the shifted position pressure is connected to one port, the other port is connected to tank. The tank port would here also be suitable for pressure service.

Drain ports are an addition to ports mentioned in the various configurations. Multiple ports are also common. A four-way valve may have two tank ports to minimize resistance to flow through the valve particularly when it is designed as a part of a machine. Catalogued four-way valves that are manufactured to cover a multitude of applications usually have the tank lines manifolded within the valve and then connected to one external port.

In switching between alternate flow paths a three or four-way valve must pass through a center position. If the spool is not held in center for any length of time,

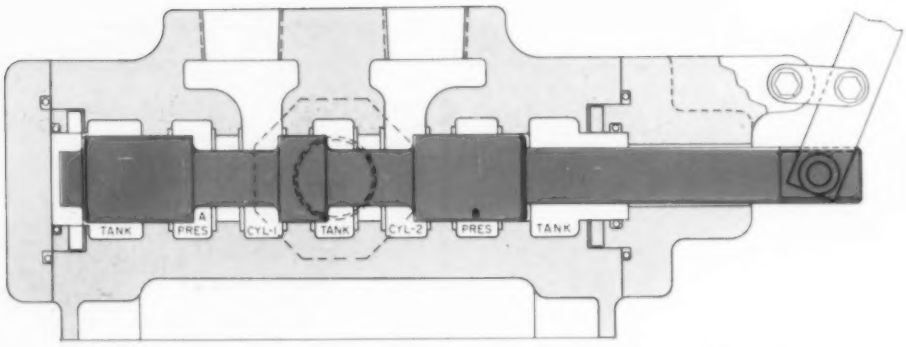


Fig. 2—A five-way solenoid actuated water valve. Ports open to two different pressures, A and B, two cylinder connections and tank. In extreme position shown pressure A is connected to cylinder 1, pressure B is blocked, cylinder 2 goes to tank. When reversed, pressure B is connected to cylinder 2 and cylinder 1 is dumped

it is designated a two position valve. A two position valve is only expected to reverse a fluid motor. When the spool may be held on center by a ball retainer or balance of spring forces it is called a three position valve.

Differences among four-way directional valves are confined to the various interconnections set up when the spool is centered and the speed and smoothness of switching between alternate flow paths. Since by far the majority of directional valves are of the sliding spool type, and since the three-way valve is, in most applications, a simplified (one port blocked) version of the four-way valve, this discussion will be confined to four-way valve spool designs.

Basic Construction

Many four-way directional control valve main bodies are made symmetrical so that the operating spool can be assembled from either end. This construction normally uses a loop core in the casting as the method of connecting the end valve ports together and to the proper exterior connection. To decrease physical size of directional control valves it is necessary to eliminate the loop coring in the valve body casting. The center of the valve spool is hollowed out with suitable connecting passageways to cover the requirements formerly served by loop coring. Fig. 3 illustrates the common closed center spool design when hollowed out.

Closed Center Valves

The term closed center indicates that flow through the valve is momentarily stopped as the spool travels from one extreme position to the other. At the midpoint of travel the cessation of fluid flow locks pressure in the several lines connected to the valve. In a two position

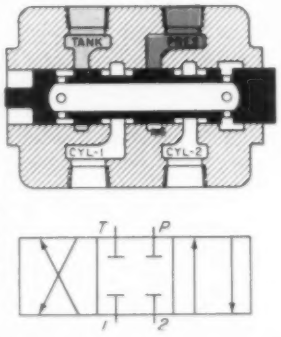


Fig. 4 — Closed center spool with throttling grooves to smooth acceleration and deceleration during reversal. Flow is cut off gradually but longer lands limit maximum flow for the same size of valve envelope.

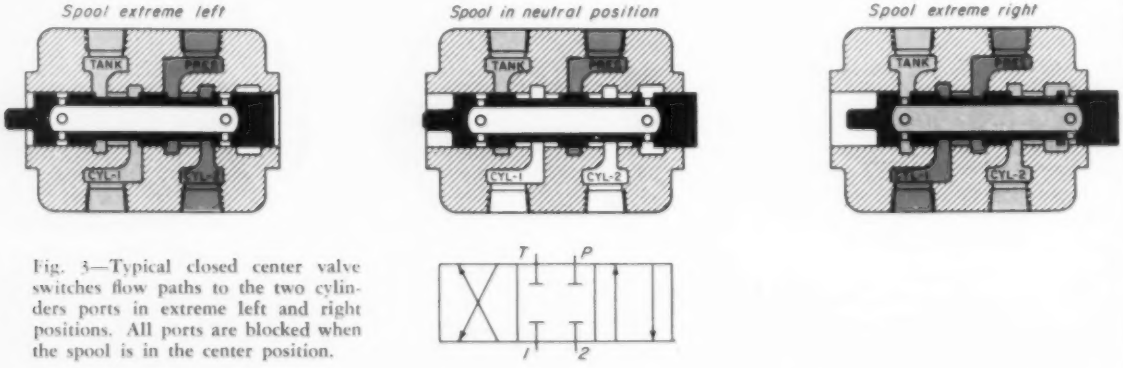


Fig. 3—Typical closed center valve switches flow paths to the two cylinders ports in extreme left and right positions. All ports are blocked when the spool is in the center position.

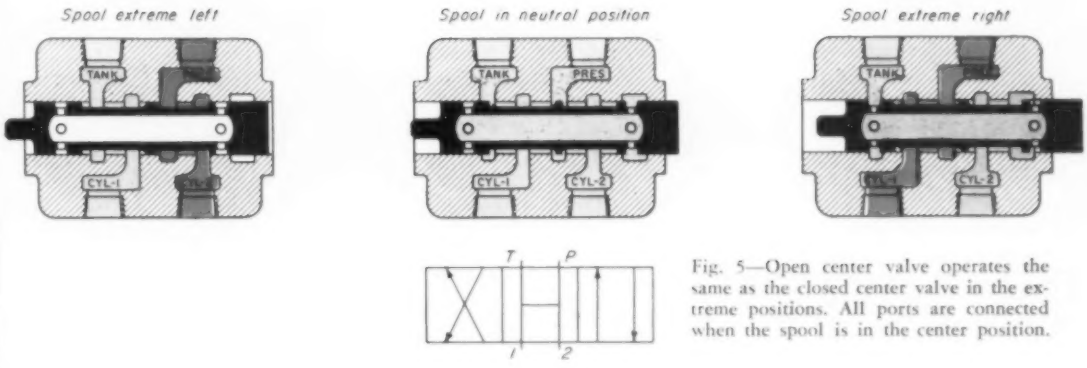


Fig. 5—Open center valve operates the same as the closed center valve in the extreme positions. All ports are connected when the spool is in the center position.

valve this midpoint of spool travel is only of importance if the open or closed center condition will affect the machine operation. If an accumulator is used in a circuit a closed center spool design will prevent undue loss of fluid from the accumulator during the brief period of time necessary to shift the spool from one extreme end position to the other.

A closed center spool may be modified to assist in controlling acceleration, deceleration, compression and decompression by including notches or ground angles on the edges of the spool to open and close the flow passages in a more gradual manner. A closed center spool with throttling devices incorporated is illustrated in Fig. 4. Usually this modified spool will not have quite as much flow capacity as the square ended spool. Longer spool lands are necessary for sufficient linear travel to incorporate the throttling construction.

Only machine movement that may occur on center of a closed center valve is a function of clearance flow past the lands of a metal to metal sealed valve. A packed valve may be assumed to be dead tight.

Open Center Valves

An open center spool design is illustrated in Fig. 5. In two position valves this construction offers built in shock protection. Assuming the circuit does not include accumulators and a momentary drop in system pressure may be tolerated, the open center spool precludes any sudden pressure build up and release as the spool shifts across center. At the exact center position all parts are interconnected and dumped to tank.

In addition, pressure release as the valve crosses center permits all machine members to relax momentarily before taking up the reverse load. As the valve centers all flow paths are connected together and to the reservoir. Pressures drop to zero until the spool has nearly completed its shifting operation. Normal friction forces in machine slides will help in decelerating the load and accelerating it in the reverse direction during the valve shifting operation.

Since in the use of two position valves there is no particular need to dump full flow to tank as the spool traverses center, considerable latitude is possible in spool design. Angles or notches on an open center spool permit transient flow control without losing the open center condition entirely. Fig. 6 is an example of a throttled open center valve often referred to as a partially open center spool. Flow capacity may be restricted during cross over to allow a relatively small pressure drop and firm acceleration and deceleration. In some installations throttling also may be desirable for compression or decompression purposes. (Turn page)

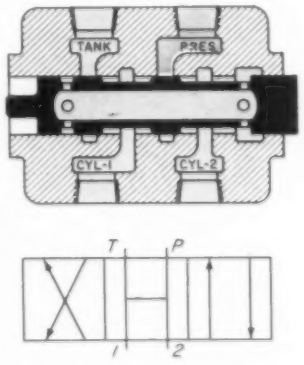


Fig. 6—A throttled open center valve is incapable of dropping line pressure to zero, but it reduces line pressure to a value sufficiently low to eliminate shock waves and assist in acceleration and deceleration of the load members.

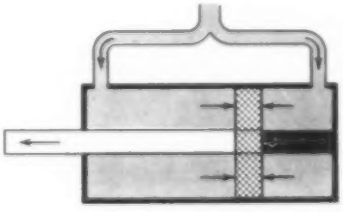


Fig. 7—A low pressure acting equally on both sides of a single rod piston works against two different areas. Result is a simple ram which will move if the pressure times rod area is greater than frictional resistance of piston and machine member and associated loads.

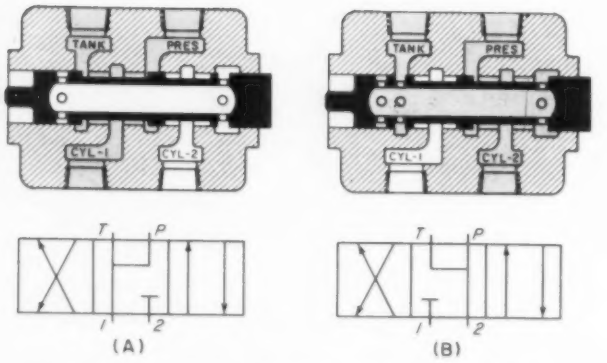


Fig. 8—Unsymmetrical design sets up a longer flow path to the tank connection in B than in A. Pressure drops will not be identical for the two valves though their JIC symbols and function are the same.

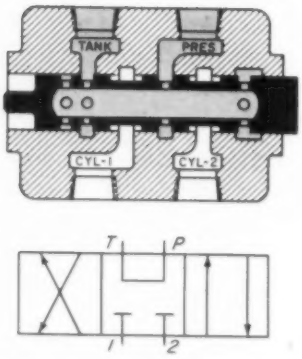


Fig. 9—Flow from pressure to tank ports is fairly direct and pressure drop in neutral position will be low. Both cylinder ports are blocked and piston movement is limited to clearance flow.

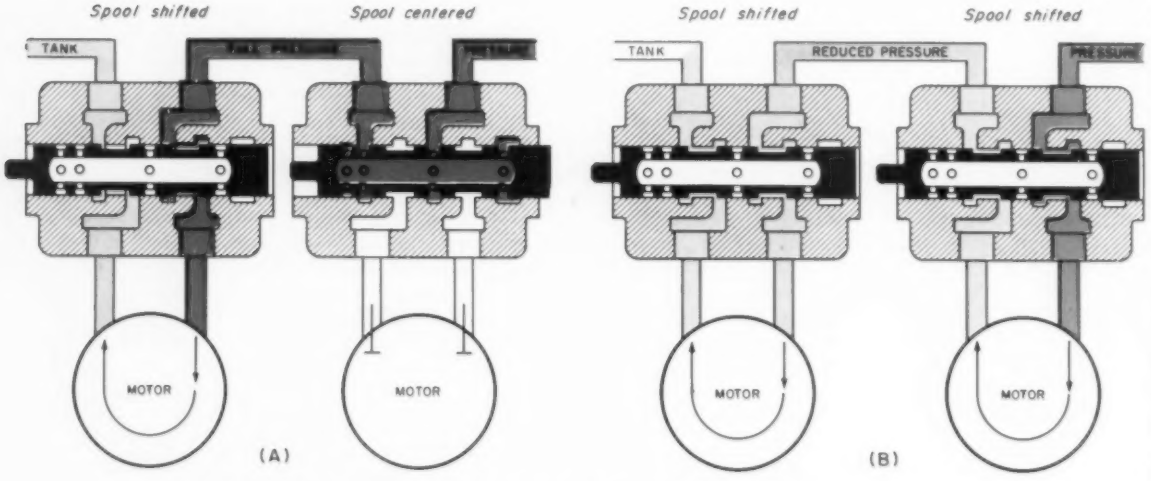


Fig. 10—Series circuit using the valve of Fig. 7 permits actuation of two or more devices from a single pressure scource. If only one valve is shifted (A) its motor receives full pressure. If both are shifted (B) a reduced pressure is generated.

Three Position Valves

More complex spool configurations may be required by three position valves whose center position is used in an operational rather than transient mode. Extreme end positions still provide straight and reversed flow channels for the two connection pairs but the center position may be the basic open or closed center with or without throttling, or it may be any combination of interconnected or blocked ports.

An open center valve connecting all four channels is undesirable in some circuits. If the line to the reservoir is long or small the high flow resistance may start a cylinder moving as shown in Fig. 7. All four channels at the valve will be at some low pressure and the differential area on the piston permits creation of an unbalanced force. Rotary fluid motors or double end rod cylinders are immune to this problem unless the valve has not centered exactly and pressure drops are unequal across the cylinder channels.

When an open center valve has been connected to a cylinder or fluid motor the piston is in a free floating condition when the valve is centered. No hydraulic obstruction other than fluid friction prevents piston movement if external forces are applied. To eliminate this, one of the two cylinder ports may be blocked while the second is permitted to flow freely to tank as shown in Fig. 8. This construction reduces centered flow capacity through the valve roughly to half of the flow through symmetrical loop core designs. In the bored out spool of Fig. 8, the two methods of design do not have equal pressure drops to tank because of the differences in flow paths.

Tandem Spools

Another method of preventing cylinder drift in neutral position yet still diverting pressurized fluid to tank is shown in Fig. 9. In neutral position both cylinder ports are blocked and input pressure is connected to tank. This spool design usually directs fluid to tank with a minimum of resistance. Flow from pressure port to tank is through large drilled holes into the spool center and fluid traverses roughly half the spool length on its way to the tank port.

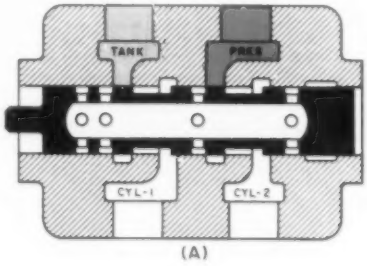
This construction is called a tandem spool design and is widely used to connect the flow path for valves piped in a series circuit as shown in Fig. 10. In a series circuit pressure enters the first valve, and is discharged into the input of the second and so on as required by the circuit. Maximum allowable pressure drop determines the number of valves that may be connected in series.

When all valves are in neutral flow goes directly from pressure to tank subject only to the pressure drops due to flow resistance. When any valve is shifted fluid is directed through the valve to the motor in normal directional valve function. When both valves are shifted, total pressure divides itself across each valve according to the ratio of loads on the motors.

Tandem spools are often provided with ground notches or angles for smooth flow characteristics during the shifting operation.

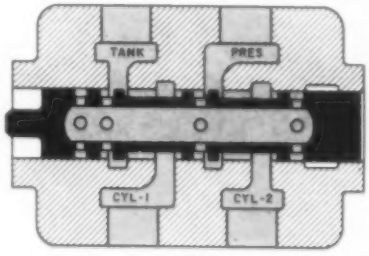
There are two basic types of tandem spools. The first is constructed so that as the valve is shifted from neutral it will close the pressure port off completely before setting up the standard connections of pressure to one cylinder port and return cylinder port to tank. This is a closed cross over design as in (A) of Fig. 11. In vertical cylinder installations a piston might drift down before starting up if the lower cylinder port was opened to pressure and tank before pressure and tank connections were blocked.

If a cylinder is operated horizontally or is counterbalanced an open cross over tandem spool may be used as shown in (B) of Fig. 11. All ports are connected to the reservoir until the spool is either in an extreme position or definitely in neutral. Shock of pressure rise during shifting is avoided in this design. It is apparent that in some applications a compromise between those two spool arrangements is possible and desirable.



(A)

Fig. 11—Two tandem spool designs drawn in crossover position between neutral and extreme shift to the left. In (A) pressure is blocked before connection to cylinder 2. In (B) pressure is relaxed to tank before connection to cylinder 2.



(B)

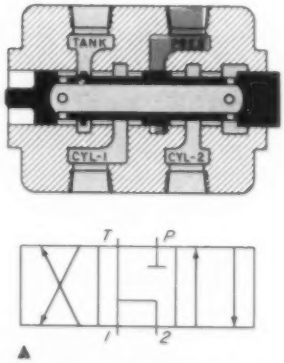


Fig. 12—Pressure is maintained in an accumulator when the spool is in neutral but the piston may be mechanically driven since free flow is permitted between cylinder ports and tank.

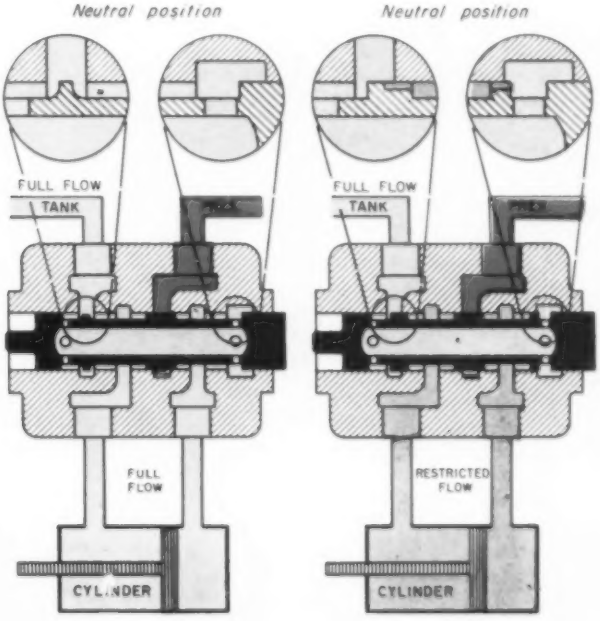


Fig. 13—Comparison of a standard pressure port blocked spool with a notched spool to severely restrict flow between cylinder ports and tank.

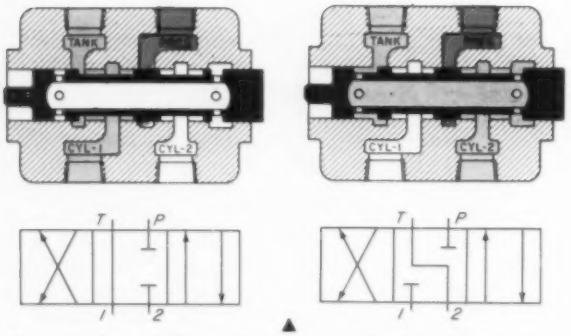


Fig. 14—Alternate forms of a valve spool with pressure port and one cylinder port blocked in neutral position.

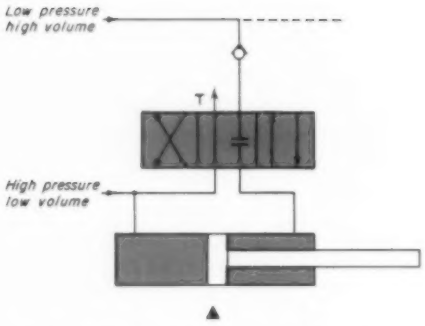


Fig. 15—Low pressure oil establishes rapid traverse until work resistance is met. Pressure rise then closes off check valve and high pressure along finishes work cycle. Low pressure oil establishes high speed reversal. High pressure is dumped. When spool is in neutral, low pressure port is blocked so that other valves and cylinders may be operated from this supply. High pressure dumps to tank at low resistance.

Fig. 16—In neutral position, as shown, a single rod and cylinder will work regeneratively setting up high speed forward. This spool configuration is required in pressure centering devices for definite neutral positioning.

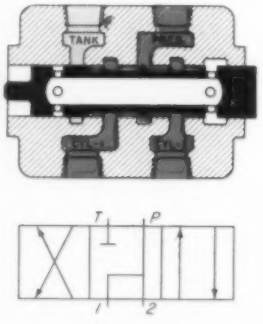
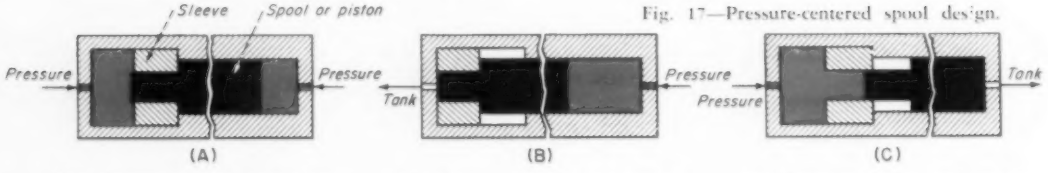


Fig. 17—Pressure-centered spool design.



(A) Pressure at both ends forces sleeve against housing; in reverse, forces piston against sleeve.

(B) Pressure at right end permits piston to pick up sleeve and carry to left end plate.

(C) Pressure at left end pushes sleeve to shoulder and forces piston to the limit of its travel.

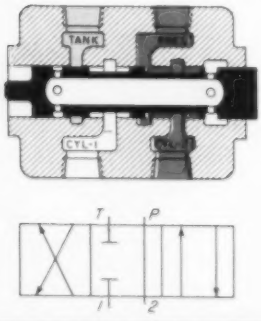
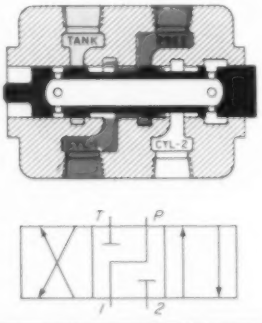


Fig. 18—Two variations on tank port blocked spool configuration close off one of the cylinder ports as well as the tank port. Pressure is applied to the second cylinder port in neutral position. Extreme end positions are standard.



Pressure Port Blocked

Cylinder lines are relaxed but the pressure port is blocked by the valve spool shown in Fig. 12. The piston may be moved mechanically when the valve spool is in neutral as may be required when a cylinder parallels a lead screw for fast traverse and precise lead screw positioning.

Practically all pilot sections of pilot operated four-way valves are designed in this fashion. The pilot spool is spring centered when the solenoids are de-energized. Springs on the ends of the main spool urge fluid out of the pockets through the pilot body.

If only sufficient pressure relaxation is required to make certain a piston will not move because of area differentials, small angles or notches may be ground on the spool lands to relax cylinder lines in neutral and throttle flow as the spool is shifted. Fig. 13 compares complete relaxation of cylinder ports in the neutral position to the restricted flow possible with ground notches. Pressure port is blocked in both valves.

Notched, pressure port blocked, spools are widely used in machines in which creep cannot be tolerated but smooth acceleration and deceleration are essential. They are actually more like an all port blocked spool with restricted bleed between cylinder ports and tank.

If only one cylinder port is to be connected to tank and all other ports blocked the valve spool will look like those in Fig. 14. It is possible to remove pressure from packing lines or hoses and yet hold one end of the cylinder locked with these valves. These spools are also used in a parallel circuit as shown in Fig. 15 with one source of low pressure fluid for rapid traverse of several cylinders and a high pressure, low volume pump for each cylinder to apply large forces.

Notched spools to relax pressure slightly set up a controlled bleed to tank when the spool is in neutral. Pressure build up from clearance leakage is prevented where it would be detrimental to machine operation.

Tank Port Blocked

Pressure may be applied to both cylinder ports and the tank port blocked in neutral position as shown in Fig. 16. This spool intentionally causes a single end rod cylinder to travel until the valve is shifted in the conventional manner to an extreme position. This is one method of causing a regenerative action. Oil from the rod end of the cylinder is directed both through the valve porting to the head end combining with the incoming fluid from the pressure generator.

This spool configuration is widely used with pressure centering devices in which a shouldered piston and sleeve establish an area balance in neutral as shown in Fig. 17. The piston or spool is moved by maintaining pressure on one end and relaxing pressure on the other. When pressure is applied to both ends the spool comes to a neutral position established by the housing.

Two variations on the tank port blocked spool are shown in Fig. 18. One cylinder port is pressurized and the other blocked. In certain installations it is desirable to pressurize one cylinder end in the neutral position to keep it from getting out of pace with the rest of the machine.

Summary

Spool configurations described above do not cover all of the spools used in hydraulic industry today. However, diversion spools, dual two-way, three-way, servo construction, auxiliary pilot control spools and the many modifications of the spools illustrated are simpler to understand once basic types are known.

EDITOR'S NOTE: Three earlier articles in this series covered the function and application of "Relief Valves," December 1956 page 174, "Pressure Control Valves," January 1957 page 196, and "Flow Control Valves," March 1957 page 144.

Oil Piloted Valves—A note on spool movement

Whatever the function of two-way, four-way or relief valve certain general considerations apply when pilot operated by pressurized oil. Whether the pilot valve is remote fro mthe main valve or integral with it an auxiliary needle valve or orifice is usually installed to control the rate of spool movement. A check valve is sometimes installed in parallel with the needle valve or orifice for effecting different speeds for the two directions of spool movement.

By controlling the speed of spool movement as illustrated a degree of deceleration and acceleration control is added to the simple directional control of fluid flow.

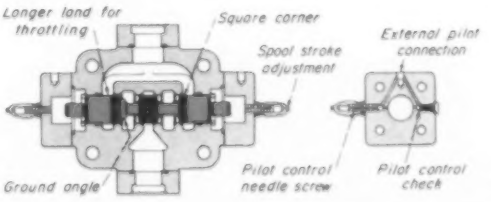
Degree of control is highly dependent on configuration of spool. Square ended, open or closed center spools are least effective in controlling transient flow, but they offer largest flow passage through the valve. Ground angles and notches machined on the edges of the spool subtract somewhat from maximum flow. If maximum flow is to be kept the same, length of spool travel must be increased with attendant slower valve action.

Additional factors affecting degree of control include configuration of needle valves, pilot pressure, viscosity of fluid medium, and the manner in which pilot pressure is applied. The last item refers to differences between spring offset, spring centered and no spring methods of spool actuation.

Regardless of valve function, a uniform shifting force can be expected from pilot operated valves in a conventional circuit. With constant pilot pressure, reasonable repetitive accuracy can be expected without introducing pressure compensating devices like those used in most flow control valves. Note, however, that changes in fluid temperature and pressure must affect speed of spool movement.

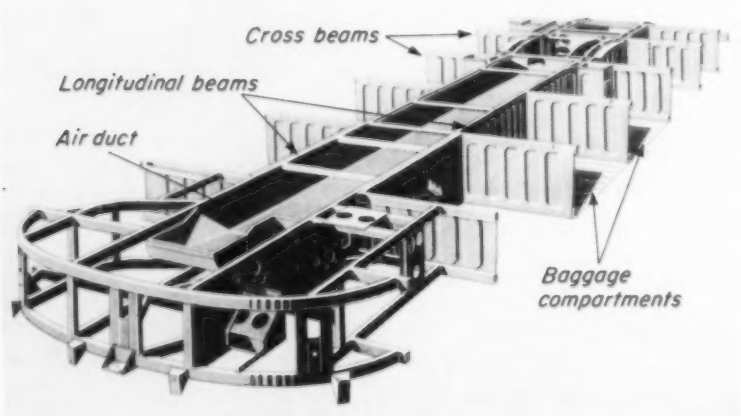
With spring centered or spring offset valves certain differences in function must be anticipated. For example, a spring centered valve will have pilot pressure plus spring force urging the spool to move away from its extreme position. Beyond the neutral position pilot pressure continues but the spring force reverses. With no pilot pressure the spring will shift the spool to neutral but only the potential energy stored in the spring is available for this function. Response is bound to be slower under spring force alone than under combined spring force and pilot pressure.

This difference is even more noticeable in a spring offset valve. Spool movement is a function of pilot pressure versus spring in one direction and of spring alone in the return. Note, too, that pilot pressure is relatively constant but spring force increases with deflection.



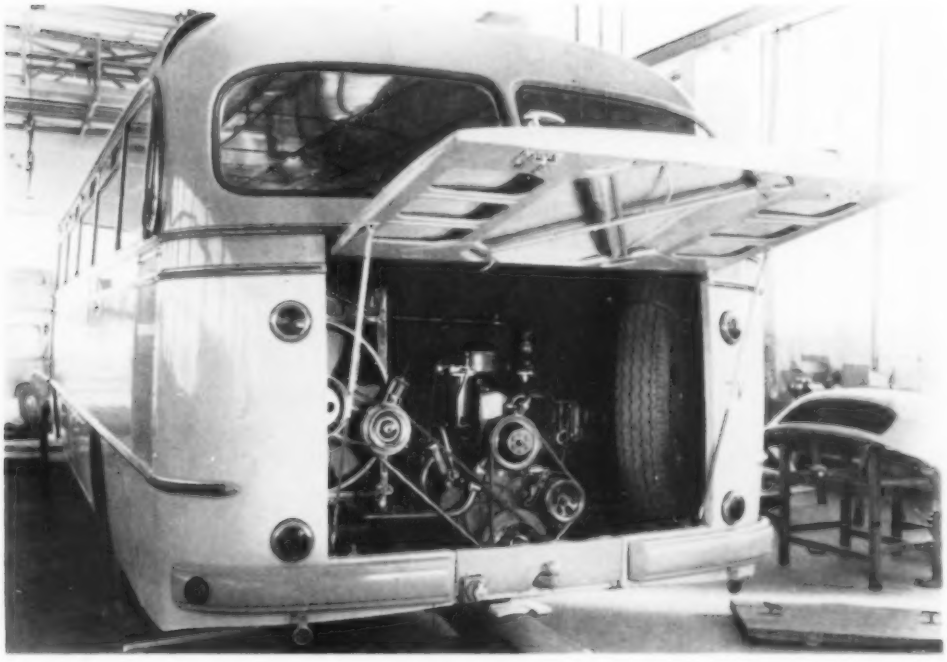
Bus Floor is Part of Frame

A box-girder structure, built of square tubes and sheet-steel webs welded into an integral assembly, forms the under-frame and body floor of the German Mercedes-Benz type 0-321-H bus. Weight is 15% less than buses using standard chassis frames while torsional rigidity is 10 times greater. High torsional rigidity and beam strength of under-frame reduce strains on superstructure, and make possible large windows and doors as well as a sliding roof section.

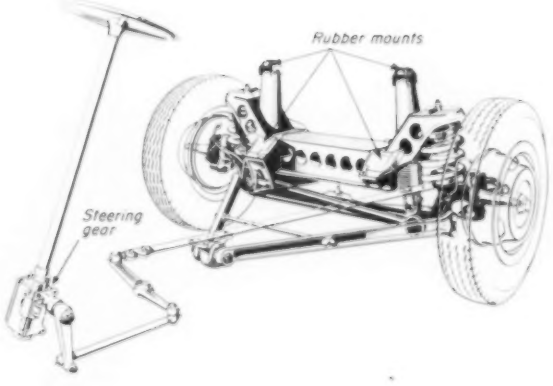


Longitudinal beams of under-frame are formed of square tubing and vertical steel sheets. Double walls are used over front and rear axles. Floor (not shown), heating and ventilating duct, and 2 beams make a center box structure with high torsional rigidity. Tubular cross-members, joined by rigid webs, extend the full width of the bus. This deep-sectioned box-girder structure, integrated by the floor panel, makes a self-supporting frame with high torsional rigidity and bending strength. The center tunnel houses linkage for clutch, transmission and carburetor, electrical harness, and piping for compressed air and heating systems. It also carries ducts which discharge air beneath the seats. Baggage is carried in compartments between the cross-beams. Under-frame takes all shocks up to 3 ft above the road.

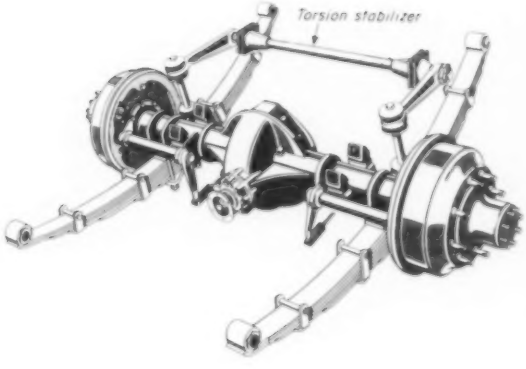
IN NEW PRODUCTS



Engine, clutch, and transmission are on a subframe which mounts in the rear of the under-frame. This assembly can be removed by loosening 6 frame bolts and disconnecting the driveshaft from the rear axle. Bus is driven by a 6-cylinder, 120-hp diesel engine.



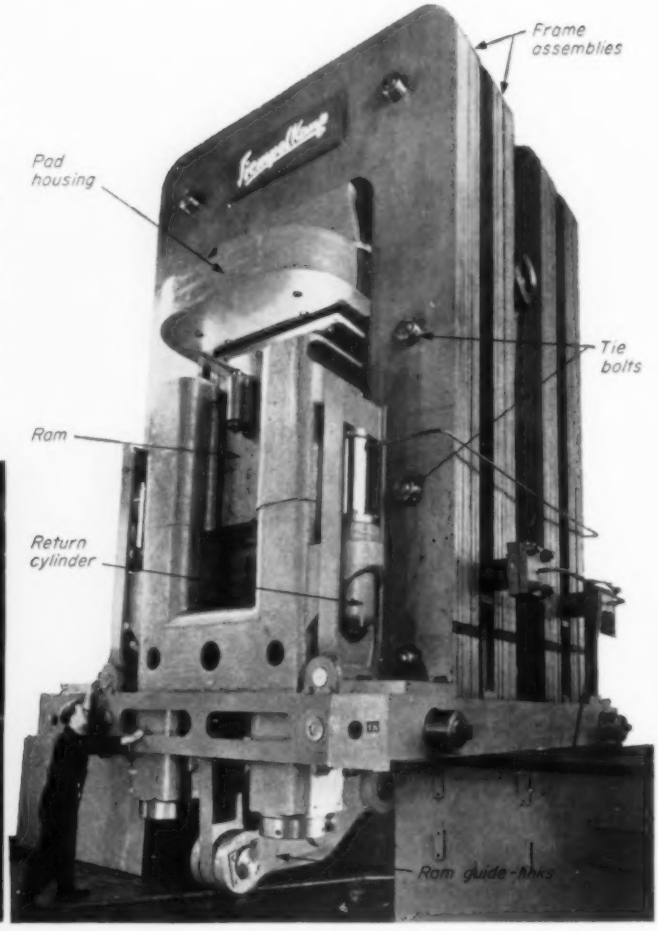
Front axle assembly is fastened to frame with rubber mounts to damp road shocks. Front suspension uses coil springs, widely spaced for high stability on turns. A triangular fork linkage transmits horizontal road shocks and braking forces directly to the forward section of the frame. Using a recirculating-ball-bearing steering gear makes possible a front-wheel turning angle of 52 deg, and a 26-ft turning radius.

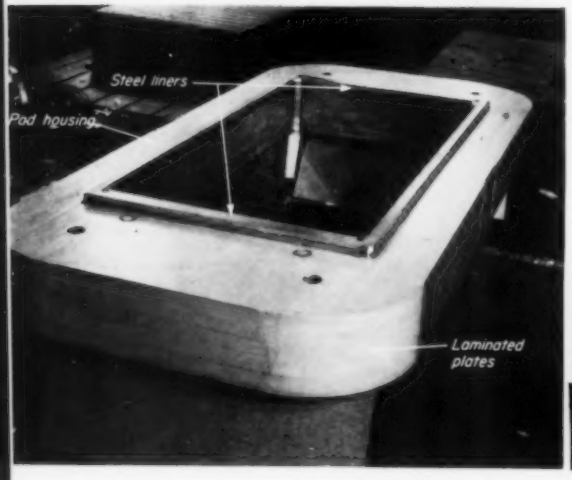


Rear axle assembly is suspended on semi-elliptic leaf springs and has a torsion stabilizer to prevent sway on curves. Hydraulic braking system is booster reinforced and produces decelerations up to 19.7 ft per sec^2. Total brake lining area (4 wheels) is 502.2 sq in. Booster-compressor piston is driven by an eccentric on the engine camshaft. Spring suspension is assembled to axle with conventional saddle and U-bolt construction.

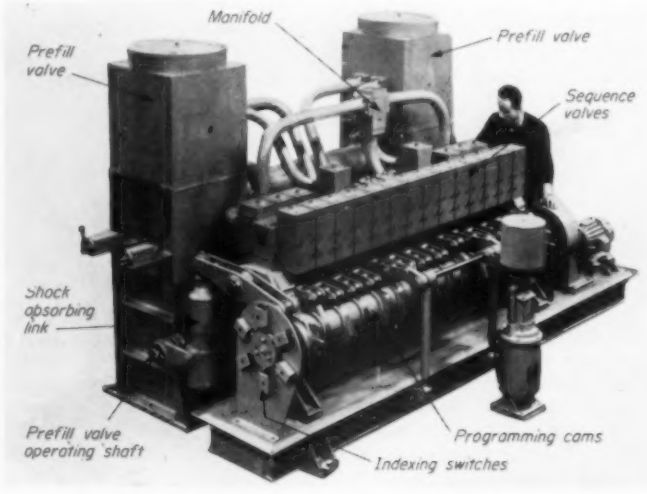
Press Has Laminated Frame

Sections cut from 3-in. steel plates and bolted together, form the frame of this 15,000-ton hydraulic forming-press made by Siempelkamp Co., Krefeld, Germany. Placing work on the ram and pushing it up into the rubber forming-pad places much of the press below floor level. This machine is used by Avro Aircraft Ltd., Malton, Ontario, Canada, to form parts for supersonic aircraft.





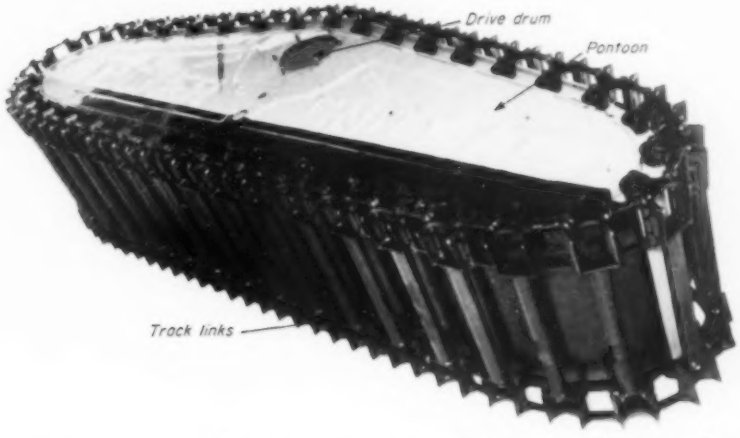
Press weighs 560 metric tons, rises 24 ft above bottom of pit and forms parts up to 1.5 by 3 meters. Frame is made of 24 plate sections which are bolted and shrunk together in groups of 6. This design has greater rigidity and a higher safety factor than a press of same weight assembled with threaded columns. Housing for the rubber pad is also formed of sheet-steel sections bolted together.



Programming valves which sequence press motions are actuated by motor-driven cams; indexing-switches, at end of camshaft, position cams for each portion of the 1 min forming cycle. Grouping valves and programming mechanism in one assembly reduces length of interconnecting piping to make system fast-acting. Oil is used as the hydraulic fluid in this system which develops a pressure of 300 kg/cm² at the die surface. Also, this compact arrangement reduces shipping weight and manufacturing cost.

Four pontoon-and-track systems driven from an engine under the hood carry this vehicle over deep snow in rugged terrain. Track links grip snow compressed by pontoons and hold fast to pull the pontoons over surface of snow packed between the links. Made by the Tucker Sno-Cat Corp., Medford, Ore., this freighter is used by the U.S. Navy in the Antarctic Expedition Deepfreeze. It travels at speeds up to 10 mph in deep snow and 15 mph on roads or broken trails.

Track Links Drive Pontoons

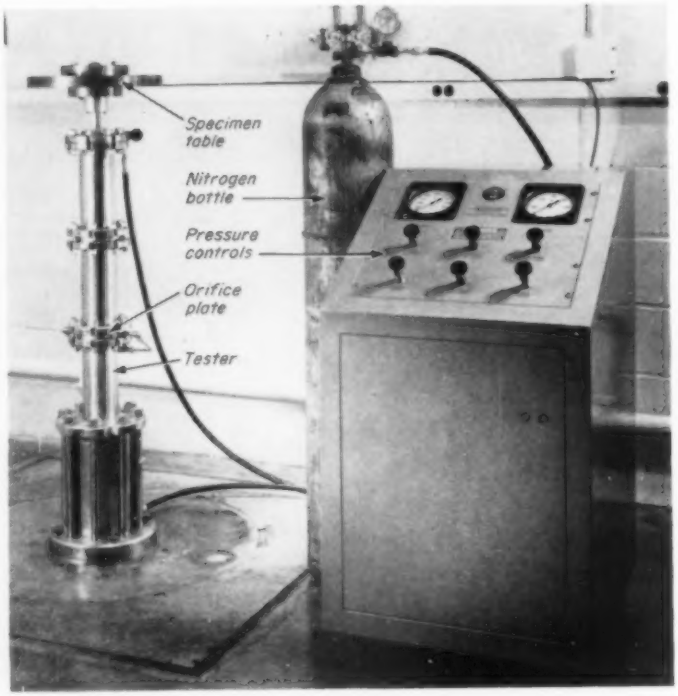


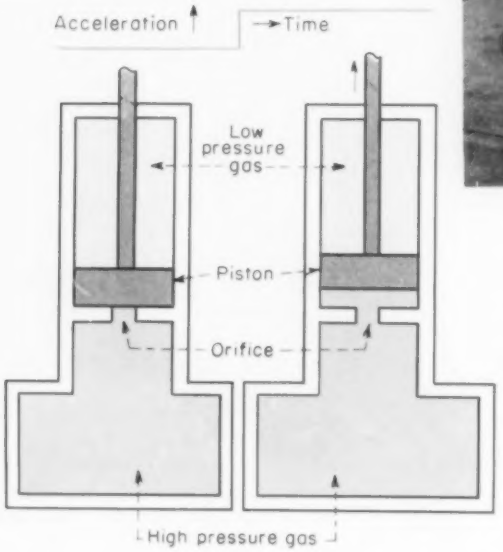
Tracks are driven by sprockets on ends of a drum in center of each pontoon. As track is pulled forward across top of the pontoon, forces resulting from tension in the rear links pushes pontoon forward as the links move around its rear end. Track links are sharp so they imbed themselves in the compressed snow under the pontoons, but are open-spaced to let snow pack between them to make a surface on which the pontoon slides. Each link rides tool-steel tracks on ball bearing rollers. Side walls push against snow and prevent excessive side slippage.

Body is made of a welded steel frame with a riveted aluminum stressed skin to obtain high rigidity with low weight. This construction keeps the center of gravity low, reduces corrosion, and is easily repaired. Power is obtained from a 235-hp Chrysler gasoline engine and is transmitted to the pontoons through Dodge truck transmissions and rear ends. The unit is steered hydraulically, and will cross or climb grades up to 65%. It weighs 7400 lb and carries a 2800 lb load. Pressure in snow under pontoons is less than 1 psi.

Compact Shock Tester

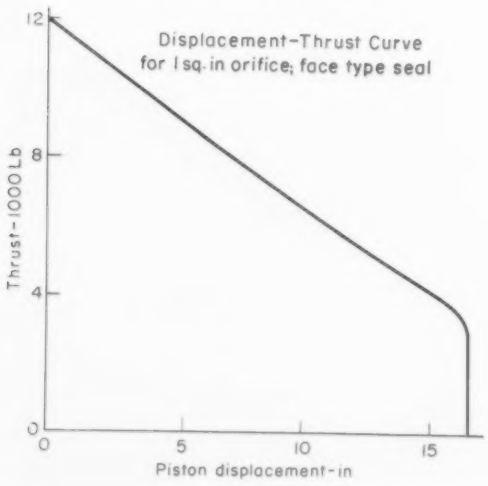
Energy released by suddenly expanding high-pressure gas accelerates test specimens on a programmed time schedule in a shock testing device manufactured by Consolidated Electrodynamics Corp., Rochester, N. Y. Both acceleration and deceleration waveforms are determined by contoured metering pins which control flow of high-pressure fluid through an orifice. Called the Hyge, this unit generates peak accelerations up to 500 g with build-up rates over 200 g per millisecond.





Thrust is triggered by overbalancing gas forces applied to opposite sides of a piston. Actuator is a cylinder divided into two sections by a metering orifice and the piston, which is sealed against upper surface of the orifice plate by gas pressure in the upper chamber. In balanced condition, high-pressure gas in lower chamber exerts an equal force against piston area exposed to the orifice. Raising pressure in lower chamber, above critical value which balances the vertical forces, breaks seal between piston and orifice plate and suddenly applies high pressure to entire bottom piston surface. Net upward force is thrust which accelerates specimen.

Specific waveforms are obtained by using a floating piston in the lower chamber and filling volume directly below orifice with hydraulic fluid. Expansion of high-pressure gas is controlled by rate at which oil flows through orifice. Attaching contoured metering pins to the moving pistons allows effective orifice area to be changed so a specific acceleration waveform is generated. Deceleration is controlled with a second orifice and metering pin inside the tester, or by an external rail-and-carriage system.

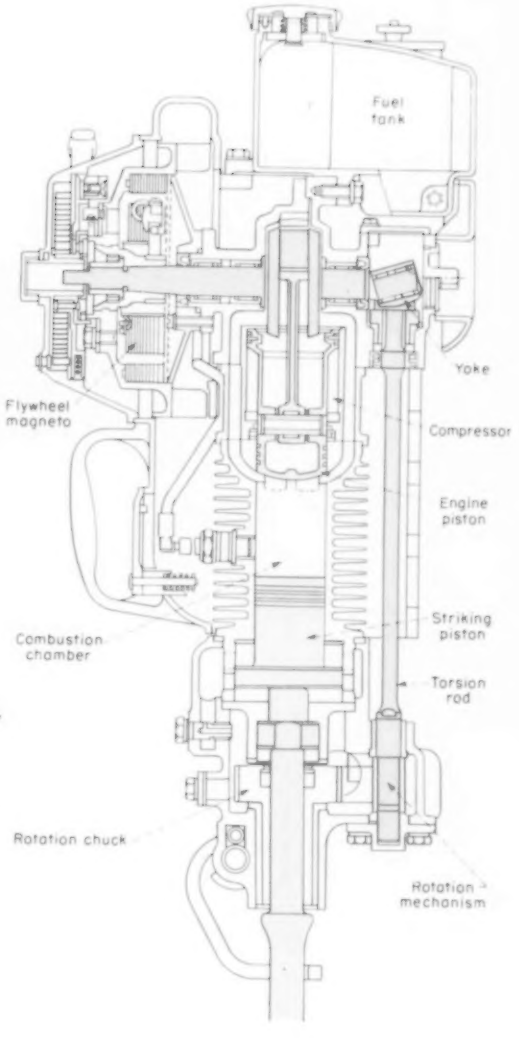


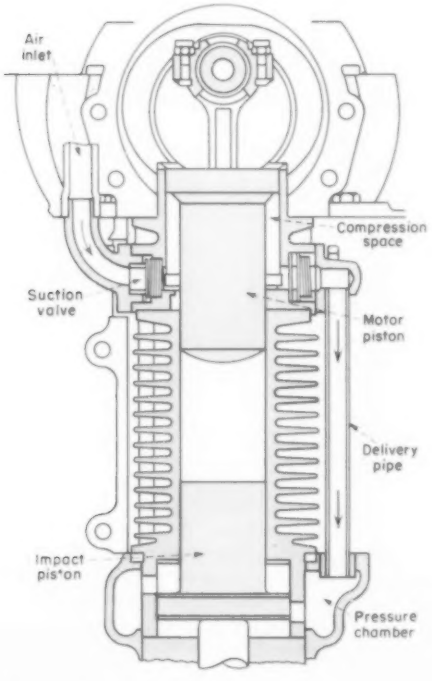
Piston displacement is a function of total volume of high-pressure gas stored in lower chamber when overbalance occurs. This determines duration of sustained thrust pulse obtainable with a particular tester. All units have a rated operating pressure of 2000 psig, and a rated maximum thrust of 12,000 lb. Thrust requirements are calculated for each mass and acceleration-versus-time program to determine which tester arrangement provides necessary thrust-displacement characteristics. Tester is assembled with interchangeable components which are arranged for the specific waveform and thrust requirement. An accelerometer, oscilloscope and polaroid camera are used to measure and record acceleration pulses.

Free-Piston Rock Drill

An opposed piston in the cylinder of an inverted gasoline engine strikes a rotated drill-bit to drill up to 13 ft through rock at 6¼ in. per min. The stepped engine piston also compresses air used as a cushion beneath the striker piston, and to blow dust from the drilled hole. Developed by Atlas Copco AB, Stockholm, Sweden, the complete machine weighs only 53 lb.

Inverted engine is a single-cylinder air-cooled unit with a 70-cc displacement. Both engine and striker pistons are stepped. Engine uses a conventional loop-scavenged 2-stroke cycle, with the combustion chamber between the cylinders. When the compressed charge is fired, the striker piston is thrown against the tool. Air in the pressure chamber beneath this piston acts as a cushion which raises it after each explosion. A skew journal on the engine crankshaft oscillates a torsion rod which rotates the tool through a pawl and ratchet chuck. Since pawl moves chuck through 2 of its 30 tooth spaces with each engine revolution, rotational speed is about 153 rpm with engine running at 2300 rpm. In event of drill seizure, rotation forces are absorbed in the flexible torsion rod.

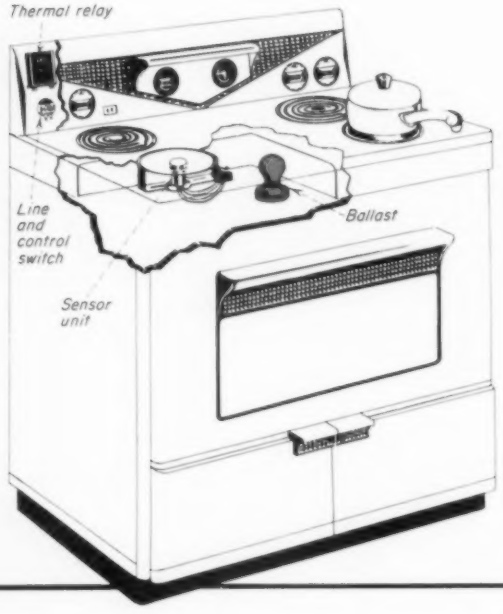


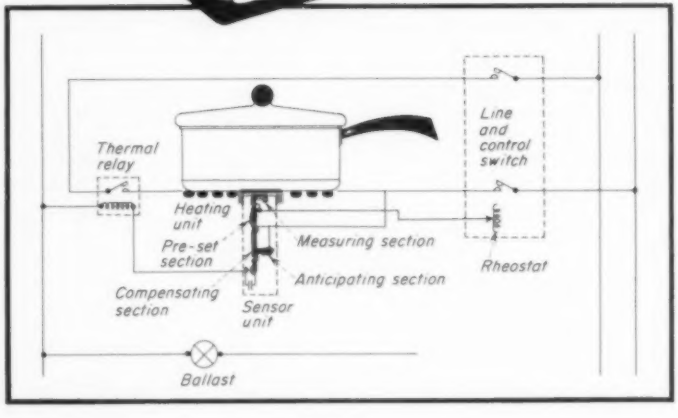


Stepped engine piston compresses air in annular cylinder space and discharges it to pressure chamber around stepped striker piston. This chamber is kept under pressure, and is ported to space beneath striker piston to raise it when combustion chamber exhausts. Air blast from pressure chamber is directed through a nozzle and along passages in chuck and drill shank to the bit. This high-velocity jet will clear dust from an 8-ft hole. Engine has flywheel magneto, cooling fan, and floatless carburetor which works at angles up to 45 deg. Unit drills 60 to 90 ft on a gallon of gasoline.

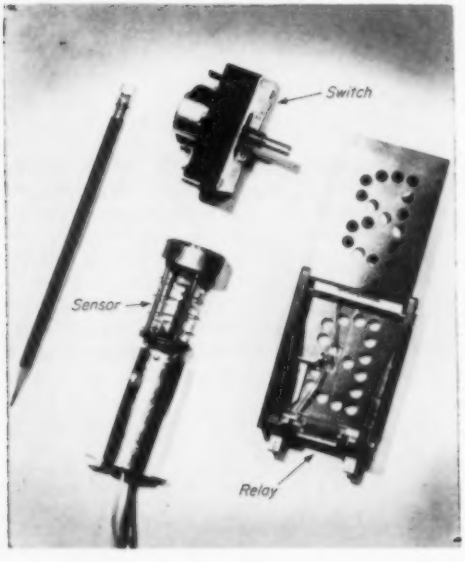
Cooking Temperature Control

An automatic system for electric ranges which controls over a wide range of preset cooking temperatures has been developed by the Bryant Electric Co., Bridgeport, Conn. Called Shur-Temp, this control uses a 3-section bimetal element to preset the cooking temperature, sense utensil temperature, compensate for ambient temperature variations, and prevent light-load cycling





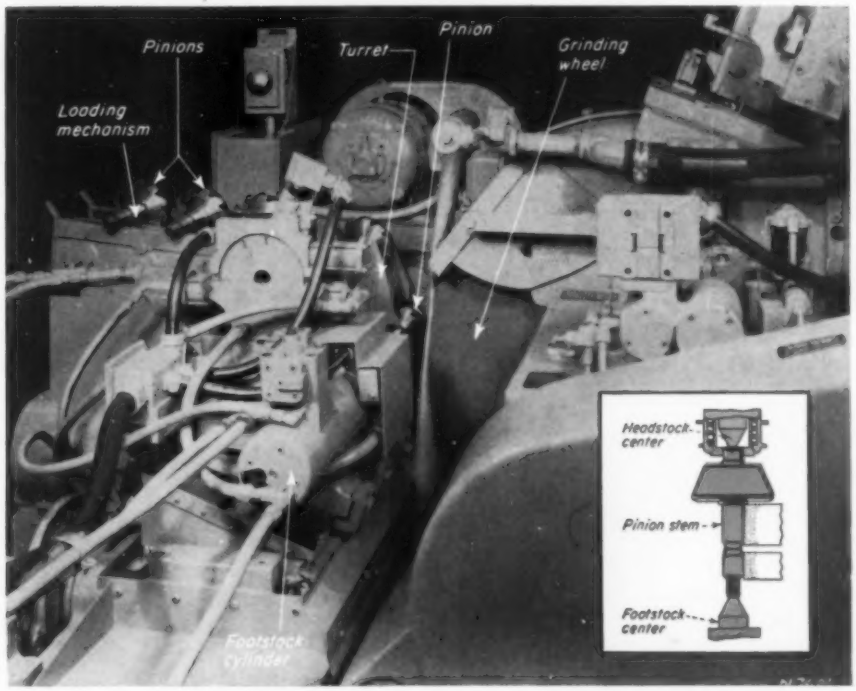
Wide variation of thermal parameters complicated the design problem. Masses to be heated vary from "boiled dry" vegetables to large quantities of fat for deep-frying. Heat transfer media vary from thin-walled aluminum pots to thick-walled glass containers. Heating elements vary from 1250 to 2600 watts although about 150 watts is adequate once the cooking temperature has been reached. Controlled temperatures range from 145 to 425 F. The designer can control only the sensing unit construction, and its position in relation to the heating elements and the cooking utensils.



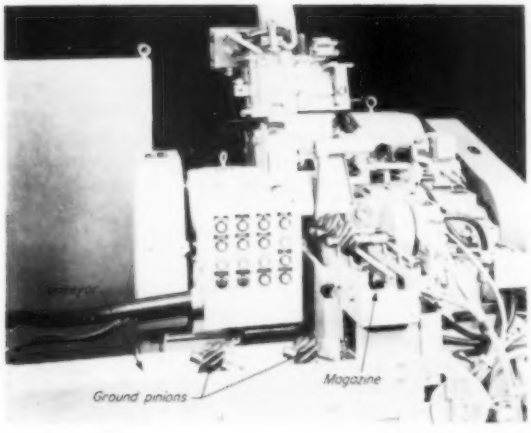
Components of system are sensing element, thermal relay, and a combination double-pole switch and rheostat. A 25-watt light bulb serves as a ballast to compensate for line voltage variations. Sensing element is lightly spring-loaded to obtain good contact with bottom of utensil. First bimetal section opens the sensor contact with rising utensil temperature. Second section opposes first section, and has a heating element, controlled by the rheostat, which sets the controlled temperature. Third section aids first section and compensates for ambient temperatures. A thermal storage mass on the third section is heated by an auxiliary element to produce anticipatory action which avoids cycling caused by time lags. Thermal relay has a ½-sec time delay.

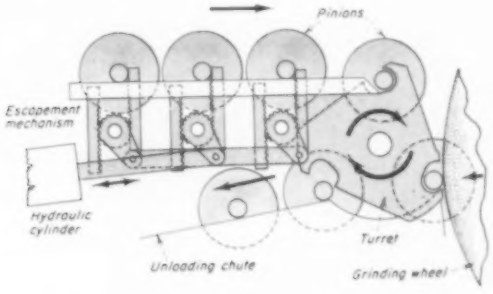
Escapement Feeds Parts

Keeping pinions separated, as they rolled down a feed chute to the loading turret, was the major problem of engineers at the Norton Co. when they designed an automatic loading mechanism for a stem-pinion grinder. Proper spacing was obtained with a stepped release escapement.



Loading mechanism feeds pinions, from the inclined magazine and positions them in a revolving turret. The turret positions each piece so it can be engaged by centers and lifted free for grinding. The footstock center, actuated by an interlock, picks up the center hole of the workpiece and then pushes the pinion onto the headstock center. Machine automatically grinds stem diameters with a single plunge.

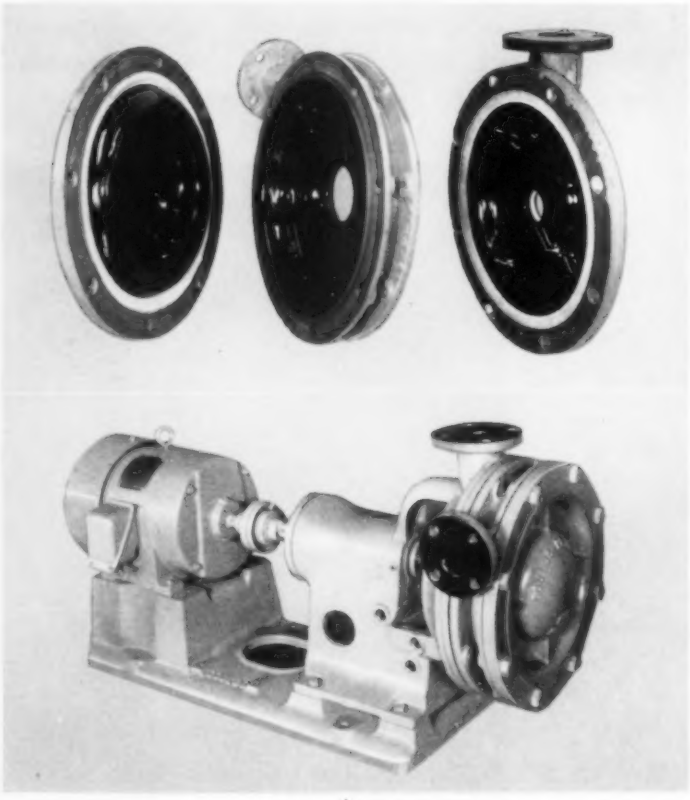




Ground pinions are released from centers and discharged into an unloading chute by the revolving turret. Parts roll from the chute onto a conveyor in front of machine. Regularity of automatic mechanism shortens cycle time by avoiding fatigue factor present when these top heavy parts are loaded manually. Grinding wheel is trued periodically, and automatically reset. Interlocks stop machine if any operation occurs out of sequence, and after a pre-set number of pinions have been discharged.

Glass-Lined Pump

A glass-lined centrifugal pump for corrosive liquids has been developed jointly by Goulds Pumps, Inc. of Seneca Falls and the Pfaudler Co. of Rochester, N. Y. Bonding glass to all exposed surfaces makes the pump suitable for a wide range of acids and alkalies. Successive applications and firings fuse the glass permanently to the iron and develop high mechanical strength and resistance to thermal shock. Products will not adhere to the glassed surface, and no catalytic effects occur in any known process.



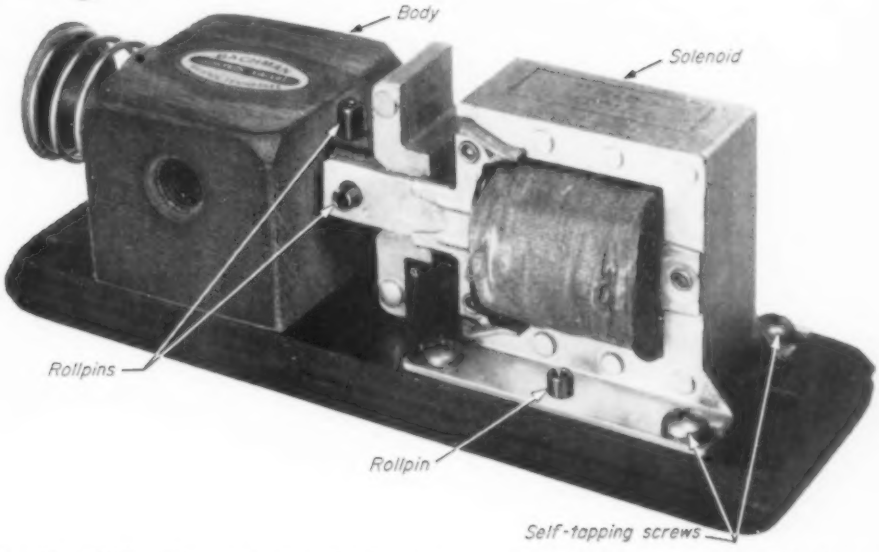
▲ **Casing is made in 3 sections** so all surfaces can be reached to apply glass. Suction flange, discharge casing and casing cover are lined on all surfaces which contact fluid, and bolted joints are sealed by gaskets with thin teflon envelopes. Three-piece construction has added advantage in ability to be assembled with discharge and suction flanges in various positions to suit customers piping arrangement.

Before glass is applied, castings are examined and all rough spots ground smooth; corner radii have been modified to hold coating thickness at contour changes. Powdered glass, in a water suspension, is sprayed on the metal and then fired at high temperature. Several coats are applied and fired individually to obtain the desired thickness. High structural strength of glass coating results from chemical bonding of glass and iron while hot, and from compressive stresses which develop in the glass as the part cools.

◀ **Impellers** required special processing as all surfaces are glassed. Glass thickness is controlled to get proper clearances between moving parts, and to allow dynamic balancing of the impellers before glass is applied. Glass coating on impeller shaft is carried beyond seal and is ground smooth to prevent leaks. With this design, the rotating member has no internal joints in contact with the fluid. Clearances between impeller and casing are greater than in metal pumps, but effect on hydraulic efficiency is balanced by lower fluid friction losses with glass surface. Coating used is resistant to all acids except hydrofluoric up to 212 F, as well as alkalis up to pH 12 at 212 F.

Valve Assembled With Spring Pins

Body, solenoid operator, and stem of this control valve are assembled with spring pins for accurate alignment and resistance to impact. Made by John D. Bachman & Co., Bristol, Tenn., the valve has a laminated plastic body which reduces noise by absorbing solenoid impacts.



Hammering action of solenoid loosened capscrews which fastened it to plastic base, although lockwashers were used to increase vibration resistance. Using spring pins as dowels reduces relative motion from impacts and makes possible the use of self-tapping screws. Fasteners cost ¼ as much, and screw holes are no longer tapped. Fastening valve body to base with 3 spring-pin dowels obviates unsightly throughbolts; using spring pins to connect valve stem and solenoid plunger, and as a stop on the stem, reduces weight of moving parts. Canvas laminate body is excellent bearing surface for valve spool. Pins used in this design are Rollpins, made by Elastic Stop Nut Corporation of America.

Bonding rubber facing to an aluminum alloy valve seat used in a jet engine afterburner fuel control enabled Chandler-Evans Co., West Hartford, Conn., to reduce both weight and cost of the part by over 50 per cent.

Double-enveloping worm gearsets, used in place of spur gear drives, enabled Stewart Bolling & Co., Cleveland, Ohio, to more than double the power transmitted to their mixers without increasing space occupied by the gearset.

Movable infrared heating elements are used to heat the platen of a vacuum forming machine made by Negri Bossi & Co., Milan, Italy. This reduces scrap by ¼ as heat can be concentrated in areas being stretched.

A vertical turbine pump circulates transformer coolant in a rotary electric welding machine made by McKay Machine Co., Youngstown, Ohio. Low lubricating value of fluid precluded using a gear pump, so a Deming 3-stage turbine pump was modified for this service.

Two-cycle diesel engines made by the Detroit Diesel Engine Div. of General Motors use exhaust-driven turbines and air impellers for supercharging with an increase in engine efficiency of 17 per cent.

Removable cylinder heads and blocks cast in pairs simplify maintenance of the engine used in a crawler tractor made by Minneapolis-Moline.

Replacing welded sheet metal parts with a zinc die casting enabled the Donaldson Co. to reduce production costs of an air precleaner to ⅓ their former level. Interchangeable cores are used to make parts with 3 different center tube diameters in the same die.

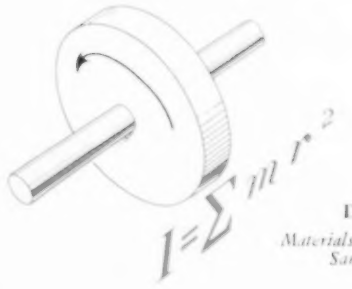
Electrically operated step switches with plug-in connections sequence pre-programmed milling operations in a skin mill developed by North American Aviation, Inc., Los Angeles, Calif.

Using a second fork as a clamping attachment enabled Yale and Towne Mfg. Co. to make a lift truck which can handle either baled material or products stacked on pallets.

Compressed air controls all motions of a convertible crawler shovel made by Thew Shovel Co., Lorain, Ohio. Unit can be converted to serve as a crane, clamshell, dragline or backhoe.

Trunnion bearings in a balancing machine made by Stewart-Warner Corp., Chicago, Ill., are mounted on springs to make them self-aligning when used with shafts of different sizes.

Three relatively simple and inexpensive pendulum systems for determining moments of inertia give precise values with known error.



D. M. ELLETT
Materials Standards Department
Sandia Corporation

How to determine MASS MOMENTS OF INERTIA *for irregular parts*

For irregularly shaped parts, the mass moment of inertia can be determined by mathematical methods which, while tedious, are precise provided the shape can be defined by equations. Graphical integration can give an approximation which may serve, but greater accuracy requires more time. Three experimental methods described here are capable of a high order of precision and are particularly advantageous for repetitive analyses of similar shapes. The equipment required for the physical test is simple and inexpensive.

In the experimental methods the test object is supported so that it oscillates about the desired axis of rotation. By measuring the period of oscillation, the moment of inertia can be computed from equations relating the period to the moment of inertia. The supporting system depends on the shape of the part and the location of the axis of rotation.

Three pendulum systems—torsion-rod, compound, and torsion-wire—will take care of most applications. In addition, a set of "error equations" have been developed for each system to evaluate the effect of individual errors in measurement on the final value for the moment of inertia.

Torsion-Rod Pendulum

The most direct method of measuring the moment of inertia of a mass about a prescribed axis is with a torsion-rod pendulum. A rod, Fig. 1, is rigidly attached to both a supporting member and the irregular object being tested. The object is twisted slightly and released, and its period of oscillation noted. Then by using vibration equations developed below, the moment of inertia is calculated.

In setting up the test, the axis of the rod is positioned to coincide with the axis about which the object is to revolve. Generally this method works best if the mass of the body is known so that the moment of inertia can be taken about the c.g. (center of gravity) instead of the desired axis. The inertia at the desired axis of rotation is then computed by using equations involving the shift in axis.

Equation of motion of the system in Fig. 1 when displacement h from center of gravity is zero, and when the test object is twisted some arbitrary small angle θ in radians in the plane normal to the rod, is given by

$$I_c \frac{d^2\theta}{dt^2} + K\theta = 0 \qquad (1)$$

where I_c is moment of inertia about the c.g. in in.-lb-sec^2, and K is spring constant of the bar in in.-lb/radian.

For round bars, using d and L as defined in Fig. 1, and G as the shear modulus,

$$K = \frac{\pi G d^4}{32L} \qquad (2)$$

Solution of Eq (1) yields the relationship between the moment of inertia and period of oscillation T (sec/cyc) of the system

$$I_c = K\left(\frac{T}{2\pi}\right)^2 \qquad (3)$$

If the axis of rotation does not pass through the c.g., the moment of inertia is

$$I = I_c + mh^2 \qquad (4)$$

where I is moment of inertia about desired axis, in.-lb-sec^2, and m is the mass of the object, lb-sec^2/in.

The moment of inertia then becomes:

$$I_c = K\left(\frac{T}{2\pi}\right)^2 - mh^2 \qquad (5)$$

When the axis is not through the c.g., some type

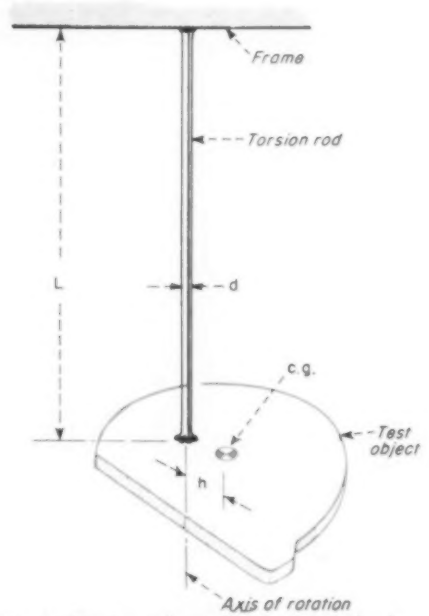


Fig. 1—Torsion-rod pendulum system is devised by fixing the test object to a frame. Moment of inertia of test object is then proportional to the square of the period of oscillation.

of constraint such as a bearing must be added to the shaft close to the body to keep the rod vertical during oscillation.

How to Calibrate the Pendulum

Accuracy of the torsion-rod method depends on the accuracy of the values used for G, d and L. Since these values—especially G—may not be accurate, it is best to calibrate the instrument by attaching to the rod a body of known shape and mass, such as a thin cylinder, whose radius of gyration has been calculated. The period of the calibrated mass will be

$$T_b = 2\pi \sqrt{\frac{I_b}{K}} = 2\pi \sqrt{\frac{m_b k^2_b}{K}} \qquad (6)$$

where k is the radius of gyration and the subscript b refers to the calibrating mass.

Dividing Eq (5) by Eq (6) gives

$$\frac{T}{T_b} = \sqrt{\frac{I_c + mh^2}{m_b k^2_b}}$$

Solving for I_c

$$I_c = \left(\frac{T}{T_b}\right)^2 m_b k^2_b - mh^2 \qquad (7)$$

In Eq (7), T and T_b are obtained experimentally; m and n_b are weighed; k_b is calculated from the known regular dimensions of the calibrating mass; and h is measured on the unit being tested by locating the c.g. by any known method, such as balancing on a knife-edge and measuring the distance between the axis of rotation and the center of gravity. For cases where $h = 0$, and where I_b is known from previous experiments, Eq (7) reduces to

$$I_c = I_b (T/T_b)^2$$

and the only value to be determined is T. It is not even necessary to weigh the object under test.

Effect of errors in measurements of the various quantities involved in determining I can be evaluated by dividing the total differential of Eq (7) by I. By definition $I = mk^2$, therefore

$$\frac{dI}{I} = 2\left[\left(\frac{T}{T_b}\right)^2 \left(\frac{m_b}{m}\right)\left(\frac{k_b}{k}\right)^2\right] \left[\frac{dT}{T} - \frac{dT_b}{T_b} + \frac{dk_b}{k_b} + \frac{dm_b}{2m_b}\right] - \left(\frac{h}{k}\right)^2 \frac{dm}{m} - 2\left(\frac{h}{k}\right)^2 \frac{dh}{h} \qquad (8)$$

where dT, dT_b, dk_b dm and dm_b are the estimated errors in measuring or calculating these values.

If the calibrating mass has approximately the same mass and moment of inertia as the unit under test, then the quantity within the first set of brackets is approximately equal to unity.

It is usually easy to suspend the mass being tested so that h is small compared to k. Thus, both the $(h/k)^2$ terms approach zero and may be neglected. Also, if the calibrating mass is of homogeneous material and of machined dimensions, k_b may be accurately determined so that the error, dk_b/k_b, is negligible. Error Eq (8) then reduces to

$$\frac{dI}{I} = 2\left[\frac{dT}{T} - \frac{dT_b}{T_b}\right] + \frac{dm_b}{m_b} \qquad (9)$$

Eq (9) states that the maximum error is twice the arithmetical difference in the error in timing the periods, plus the error in determining the mass of the calibrating billet. Errors in timing and mass may be either positive or negative.

Compound Pendulum

A method for determining the moment of inertia of a mass with respect to an axis that does not pass through the test object or where the axis is approximately in the same plane as that of the mass is shown in Fig. 2. The mass is suspended by two strings at the desired distance from the axis of rotation and then impulsed to swing in planes at right angles to the axis.

Exact solution for the period of swing, neglecting damping, is

$$T = 2\pi \sqrt{\frac{I}{mgh}} \left[1 + \frac{1}{4}\sin^2\frac{\alpha}{2} + \frac{9}{64}\sin^4\frac{\alpha}{2} + \ldots\right] \qquad (10)$$

where α is the angle through which the pendulum swings on either side, deg; g is the acceleration of gravity, in./sec^2; and I is the moment of inertia of the mass with respect to the axis of rotation.

The series in th parenthesis can be ignored in most tests because angle α is usually small and the series, for

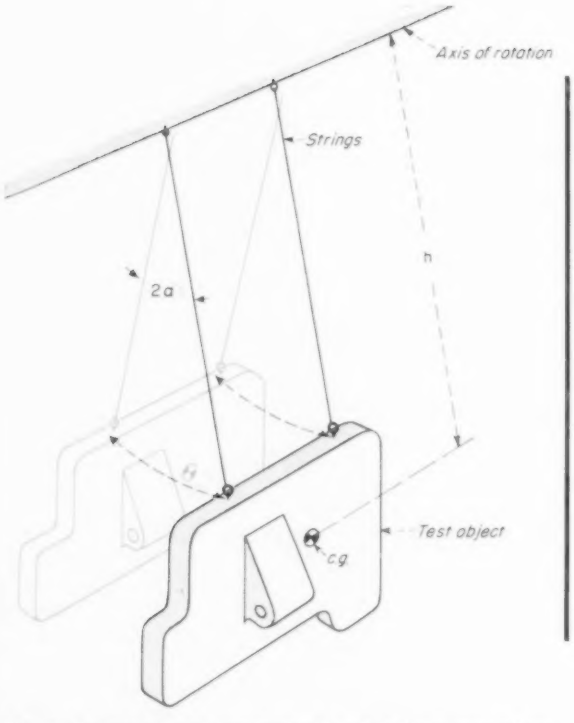


Fig. 2—Compound-pendulum method is adaptable to cases where the axis of rotation does not pass through the test object or where the axis is approximately in the same plane as the test object.

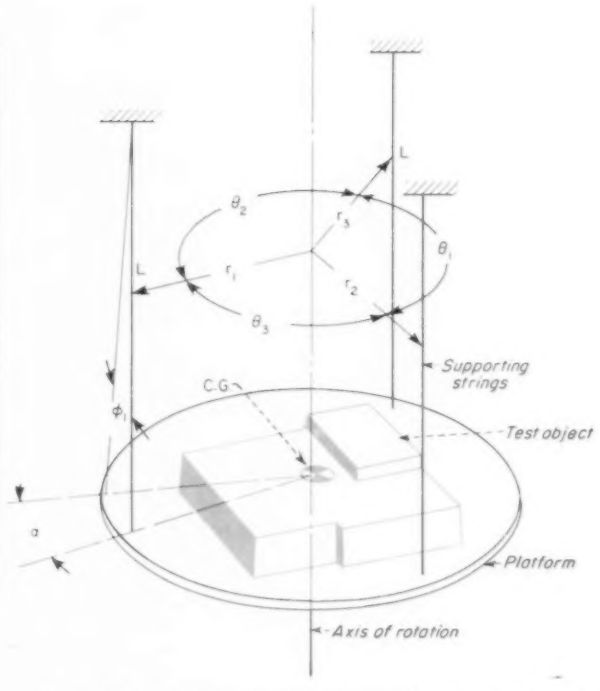


Fig. 3—In the torsion wire-method, test object is placed on a platform supported by three strings. The platform is then twisted, released and its period noted.

all practical purposes, is equal to unity. For a total amplitude of 15 deg, for example, the series equals 1.001. Also, if I is desired about the c.g. Eq (10) reduces to:

$$T = 2\pi\sqrt{\frac{I_c + mh^2}{mgh}} \qquad (11)$$

Next step is to evaluate the error in determining I_c caused by errors in determining T, h, g and m. Angle a is not included in the error analysis because errors in its measurement have negligible effect on the other factors.

Rearranging terms in Eq (11) gives:

$$I_c = \left(\frac{T}{2\pi}\right)^2 mgh - mh^2 \qquad (12)$$

Error equation is obtained by differentiating Eq (12)

$$\frac{dI_c}{I_c} = \frac{2(k^2+h^2)}{k^2}\frac{dT}{T} + \frac{(k^2-h^2)}{k^2}\frac{dh}{h} + \frac{dm}{m} + \frac{(k^2+h^2)}{k^2}\frac{dg}{g} \qquad (13)$$

Torsion-Wire Pendulum

If a platform is suspended by three parallel wires of equal length L, Fig. 3, the platform and mass will rotate about their combined center of gravity. The distances from the center of rotation to the points of suspension are designated as r_1, r_2, and r_3, and the angles between these radial lines as θ_1, θ_2, and θ_3, the units being the same as those used in the preceding methods.

Angular position of the platform is designated by angle α, and angles ϕ_1, ϕ_2 and ϕ_3 designate the angle that the wires make with the vertical; then

$$r_1\alpha = L\phi_1$$
$$r_2\alpha = L\phi_2$$
$$r_3\alpha = L\phi_3$$

In addition, the weights that each of the three wires carry are designated as W_1, W_2, and W_3. If I is the moment of inertia of the platform and mass rotating about their combined center of gravity, then torque $= I\,d^2\alpha/dt^2$. Since the torque supplied by W_1 is $W_1 r_1 \sin\phi_1$, etc., the equation of motion is

$$I\frac{d^2\alpha}{dt^2} + W_1 r_1 \sin\phi_1 + W_2 r_2 \sin\phi_2 + W_3 r_3 \sin\phi_3 = 0 \qquad (14)$$

If angles ϕ are small, then $\sin\phi$ approaches $r\,\alpha/L$, and Eq (14) becomes

$$\frac{d^2\alpha}{dt^2} + \left(\frac{W_1 r_1^2 + W_2 r_2^2 + W_3 r_3^2}{IL}\right)\alpha = 0 \qquad (15)$$

Solution of this equation yields the relation between the period of oscillation T, and the moment of inertia of the system:

$$I = T^2\left[\frac{W_1 r_1^2 + W_2 r_2^2 + W_3 r_3^2}{4\pi^2 L}\right] \qquad (16)$$

To avoid having to determine loads W_1, W_2 and W_3, moments are taken about r_1, r_2, and r_3, resulting in

$$I = \frac{W r_1 r_2 r_3}{4\pi^2 L} T^2\left[\frac{r_1\sin\theta_1 + r_2\sin\theta_2 + r_3\sin\theta_3}{r_2 r_3\sin\theta_1 + r_1 r_3\sin\theta_2 + r_1 r_2\sin\theta_3}\right] \qquad (17)$$

If the wires are equally spaced and the center of

gravity of the load is at the center of the equilateral triangle formed by the wires, then $r_1 = r_2 = r_3$, $\theta_1 = \theta_2 = \theta_3$ and Eq (17) reduces to

$$I = \frac{Wr^2 T^2}{4\pi^2 L} \tag{18}$$

The error equation, substituting m/g for W, is obtained from Eq. (18),

$$\frac{dI}{I} = 2\frac{dT}{T} + 2\frac{dr}{r} + \frac{dg}{g} + \frac{dm}{m} - \frac{dL}{L} \tag{19}$$

Since the errors dr/r dg/g and dL/L can all be made negligibly small, the total error is approximately:

$$\frac{dI}{I} = 2\frac{dT}{T} + \frac{dm}{m} \tag{20}$$

At times it may be advantageous to use a two-wire pendulum at the expense of the stability of the three-wire system. Equations can be derived similarly to those for the three-wire system. Since a two-wire system will always align itself with the center of gravity in the plane containing the two supporting wires, the equation for I automatically reduces to

$$I = \frac{W\overline{r_1 r_2}\, T^2}{4\pi^2 L} \tag{21}$$

If $r_1 = r_2$, Eq (21) is identical to Eq (18) and the error equations derived for the three-wire system will hold equally well for the two-wire system.

Comparison of Methods

In the compound-pendulum and torsion-wire methods, any error in determining the mass of the test object causes the same percentage error to occur in the moment of inertia. However in the torsion-rod method, a calibrating mass is used and the error in determining the moment of inertia depends upon the error in measuring the mass of the calibrating billet. Thus, where measurements of inertia are continually being made, the mass of the calibrating billet can be determined accurately once, and then eliminated from the list of factors that may cause an error. Also, a re-run of the setup with the same calibrating mass acts as a check on the physical condition of the setup.

Error in timing the period is always multiplied by a numerical factor of 2 which is the direct result of differentiating the T^2 term. However, in the torsion-rod method, factor 2 is multiplied by the difference in error of determining the period and calibrating the mass. This implies that if the same clock is used in both cases and the error in timing is consistently in the same direction, the errors in timing tend to cancel. Consistent clock errors can be caused by constant starting or stopping errors in clutch-operated timers. In the torsion-wire method, the error is simply doubled; in the compound-pendulum method the error is, in addition, multiplied by the factor $(k^2 + h^2)/k^2$ which is generally considerably larger than unity.

The error ratio dg/g is usually very small. If a calculation of g is made based on altitude and latitude, dg/g will be generally less than 3 parts in 10,000. If the standard g of 32.1725 ft/sec^2 is used, dg/g will be less than 2 parts in 1000. This ratio appears in error measurements of both the compound-pendulum and torsion-wire methods. However in the compound pendulum, the ratio dg/g in eq (13) is multiplied by the factor $(k^2 + h^2)/k^2$ thus amplifying it, while in the torsion-wire method the ratio is isolated, and therefore dropped from the error equation.

Comparisons are not made on the same basis for all torsion-rod method, Eq (22) would reduce to

the torsion-wire method, the error equation would be

$$\frac{dI}{I} = \left[\frac{k_b T}{k T_b}\right]^2 \left[2\left(\frac{dT}{T}\right) - 2\left(\frac{dT_b}{T_b}\right) + 2\left(\frac{dk_b}{k_b}\right) + \frac{dm}{m}\right] \tag{22}$$

If the same sort of assumptions are made as in the torsion-rod method, Eq (22) would reduce to

$$\frac{dI}{I} = 2\left[\frac{dT}{T} - \frac{dT_b}{T_b}\right] + \frac{dm}{m} \tag{23}$$

Eq (23) is identical to Eq (9) except that the mass is the mass of the test object instead of the calibrating mass. For the same degree of accuracy in the torsion-wire method, every tested unit must be weighed as accurately as the calibrating mass is weighed in the torsion-rod method. It is difficult to maintain such accuracy and it may be advisable to use a calibrating mass in the torsion-wire system.

Based on these conclusions, the three methods arranged in order of decreasing accuracy are: torsion-rod pendulum, torsion-wire pendulum, compound pendulum. No general statement can be made as to the complexity of the physical setup because the size, dimensions and method of attachment of test objects vary so widely.

Rigidity, however, does influence the complexity of the setup. Lost motion between the object under test and the force-producing mechanism will render the results inaccurate or invalid. Of the three methods, the rigid connection between the torsion-rod pendulum and the test object is the most difficult to make. This difficulty does not exist in the compound-pendulum method where the test object can be suspended from a knife-edge, or in the torsion-wire method, where gravity and friction can normally be depended upon to keep a rigid connection between the test object and supporting platform.

Thus, it is often advantageous to recommend using what may seem, theoretically, to be a less accurate method on such grounds as ease of setup and operation, economy of time, and lower cost per test.

EDITOR'S NOTE: A quick, graphical method for calculating the mass moment of inertia of prismatic bodies with irregular cross-sections is given in "Calculating Mass Moments of Inertia," January 1956 page 215. Test object, or silhouette of its cross-section, is placed on a circular nomograph that is divided into concentric rings, each ring in turn divided into boxes. With the aid of a table, total number of boxes gives the moment of inertia.

The WR^2 of a rotating balanced body, such as a rotor, can be determined experimentally without disassembling the rotor by keying a pendulum to its shaft and setting it in motion. For more details see "Determining Rotor Inertia by the Pendulum Method," May 1952 page 233, and "Nomogram to Determine Parallel Axis Moment of Inertia," July 1949 page 157.

An analytical method for calculating the moment of inertia of rotating masses is given in "The Significance of WK^2 and How to Calculate It," Mid-October 1954 page H24.

Wyman Goss C. B. Sung Earl C. Barnes

You will hear them at the . . .

DESIGN CONFERENCE

With 375 exhibitors (last year there were 172), the Second Design Engineering Show is jamming three floors of New York City's new Coliseum. The four-day show, May 20-23, will have as exhibits the latest developments in mechanical, electrical, hydraulic, and pneumatic components, plus metallic and non-metallic materials, fasteners and finishes, and other accessories used in the field of product design.

Technical Conferences, again will be sponsored by the Machine Design Division of ASME, and backed by the four major design magazines. These sessions will be held in the mornings only, with the show opening at noon.

Opening the sessions will be a panel discussion on "Procedures in Developing New Designs." Chairman of the session is George F. Nordenholt, Editor, Product Engineering. Charles Marks will be Vice-Chairman. Panel members are: T. M. Butler, director of engineering, Burroughs Corp., Detroit, Mich.; Myron S. Curtis, engineering vice-pres., Warner & Swasey Co.; George F. Habach, vice-pres., Engineering, Worthington Corp.; Robert H. Hose, partner, Henry Dreyfus Associates, past president The American Society of Industrial Designers; William J. Russell, vice-pres., Engineering, Landers Frary & Clark; Walter Dorwin Teague, Walter Dorwin Teague Associates, past president of The American Society of Industrial Designers.

Tuesday, May 21st—A paper on "New Developments in Design and Application of Gearing," by Darle W. Dudley will open the **Mechanical Session.** Mr. Dudley will discuss the progress and developments in the art of gear design in relation to present day and future requirements. The use of prime and derating factors will be discussed, and the application of indexes—"K-factor," "unit load," and "Q-factor" will be shown for estimating gear sizes. Examples of high speed gearing, lightweight gears, and close tolerance gears will be shown, and automation factors will be discussed. "New Developments in Design and Application of Cams," by Harold A. Rothbart, will cover the acceleration limits, choice of cam contour, required profile accuracy and manufacturing methods which must be known in designing cams for high speed mechanisms and industrial machinery. Comparisons between the actual and theoretical acceleration curves will be shown. A dynamic design limit has been established as a guide in the development of new machines. Mr. Rothbart will summarize both theoretical and practical considerations for high speed cam follower performance. **Materials Session**—"Metallic Materials," by Charles R. Simcoe, is a discussion of the major developments in-

T. M. Butler H. A. Rothbart D. W. Dudley

Kurt O. Tech | J. H. Koenig | R. A. Mathias | H. J. Reindl

cluding new metals and alloys for high temperature use; new metals and alloys for use where strength-weight ratio is the most important factor; new combinations of metals such as honeycomb-sandwich construction; and new processes for improving the properties of metals and alloys. Materials included are titanium, zirconium, molybdenum, alloys of aluminum and magnesium, and nodular ductile iron. Processes are vacuum melting and casting, chemmilling and others.

"Ceramics and Refractory Materials," by John H. Koenig, Director of the School of Ceramics, Rutgers University, and Edward J. Smoke, member of the teaching and research staff of the School of Ceramics, Rutgers University. This paper will be a resumé of recent technical developments in the field of ceramics. It will include: refractories and refractory coatings; cermets; enamels; glass, dielectrics; porcelain and mechanical ceramics, along with a discussion of engineering and service properties, and principal and potential areas of application.

Electrical Session—"Selecting Motors with New NEMA Frame Sizes," by Earl C. Barnes, Asst. Chief Engineer, of Reliance Electric and Engineering Co., will include some of the significant changes in a-c and d-c motors, how the application of these new motors to motor driven equipment can effect improvement in performance, economies in first cost and operation, improved appearance, reduction in size, and other benefits by using the new electrical and mechanical features. These electrical and mechanical features will be discussed.

"Static Switching Devices," by Dr. Robert A. Mathias, Carnegie Institute of Technology. The basic logic functions of AND, OR and NOT will be described and related to relay switching circuits. Static logic power supplies, sensing and input devices, and output power amplifiers will be discussed and related to the relative cost factors for each. A description of the general procedure used for static switching systems will be given.

Wednesday, May 22nd

Mechanical Session—"Designing for Easier Machining and Assembly," by Kurt O. Tech, Vice-Pres., Engineering, The Cross Company. Mr. Tech will show how the design and shape of a part can affect the product cost through handling and assembling.

Effect of screw location on automatic assembly and design problems.

"Hopper Feeding," by Floyd E. Smith, Perry Equipment and Engineering Co. Mr. Smith will elaborate on the basic characteristics of various hopper feeds obtainable for installation on automatic machines. Proper type of feed determined by rate of feed, general toolability, area for installation. Advantages and disadvantages of each type will be given. General over-all cost of hopper installations and amortization compared to direct labor cost.

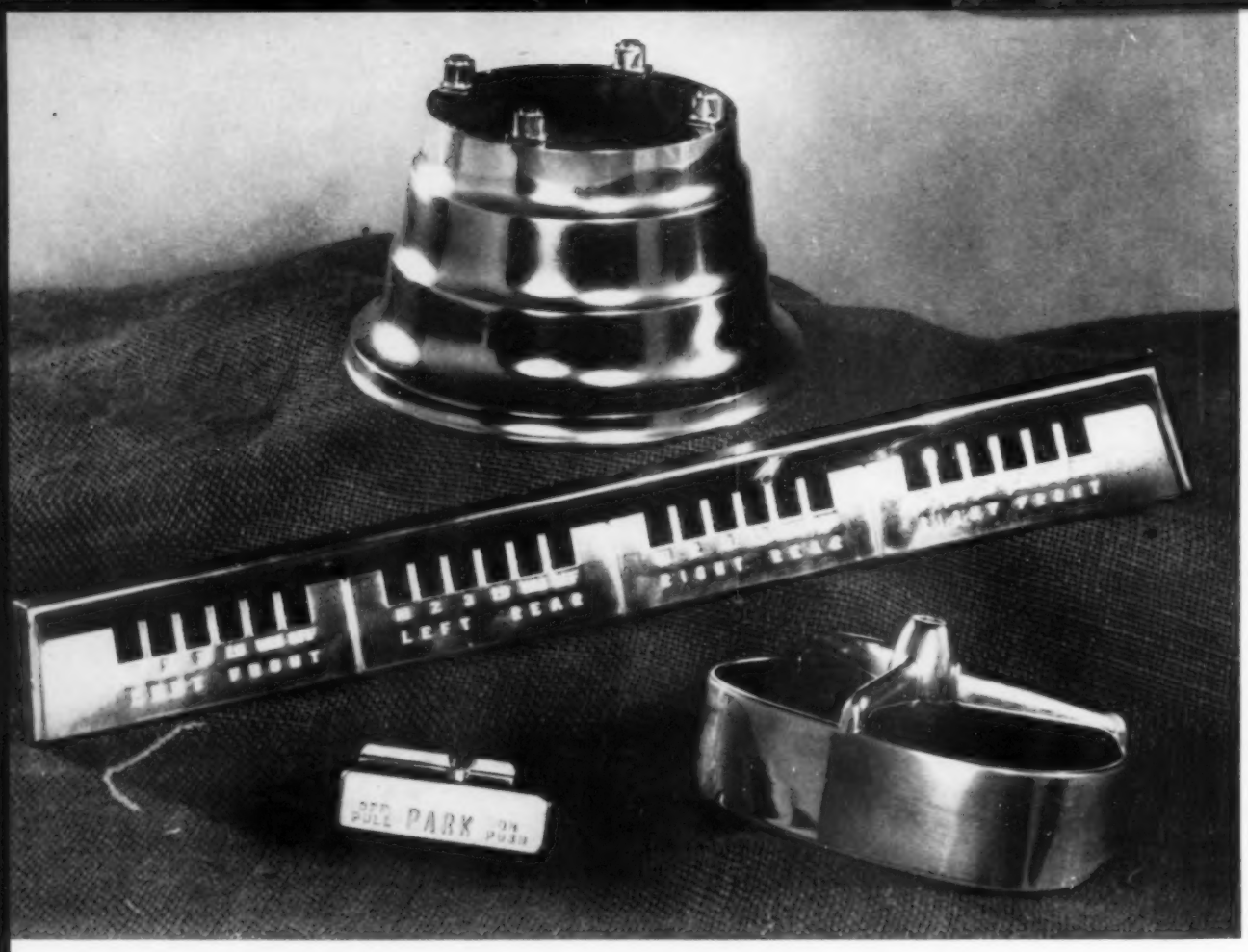
Materials Session—"Plastics and Rubbers," by Wyman Goss, Mgr., Phenolics Engineering, Chemical Materials Dept., General Electric. Plastics materials replacing older materials of construction in many fields. Ten different plastic materials or copolymers are being used in the automotive industry along in electrical systems, fuel systems, transmissions, body, running gears, engines and accessories.

"Coatings and Finishes," by H. J. Reindl, Supervisor, Research and Development, Finishes Lab., Inland Div., General Motors Corp. He discusses three general classes of coating and finishing materials: Organic coatings; Metallic coatings; Conversion coatings, Organic coatings include the varnishes and enamels. New coatings are the Epoxy, Hypalon and Polyurethane types. Metallic coatings are high vacuum metallizing, electrically conductive coatings, tungsten carbide and others. Conversion coatings such as oxides on aluminum, phosphate and chromate are but a few of the types to be presented.

Electrical Session—"Numerical Control for Machinery," by Claude D. Coffin, Warner & Swasey Co. The factors that determine the economy of applying numerical controls to machines are given. These factors include: physical size of controls, complexity, maintenance, type of data, methods used, and the preparation of records. Also to be discussed are the types of machines for which the numercial control is of doubtful value or even economically and technically unsound.

"Designing Machine Tools for Automatic Controls," by C. B. Sung, Research Lab., Div. of Bendix Aviation Corp. To achieve maximum economy, it is often desirable to design for high performance. Various considerations for adequate dynamic performance are discussed. Included are the nature of drive units, machine structure, friction, backlash, load disturbances, feedback instrumentation.

G. F. Habach | E. J. Smoke | C. R. Simcoe | M. S. Curtis



How design affects cost of Chrome-Plated Diecastings

Base material, section thickness, surface, fillets and corners, parting lines, lettering and racking — all affect cost and appearance of zinc, aluminum and magnesium diecastings.

DAN H. ROBINSON

Plant Manager
Precision Casting Co., Div. of Harsco Corp., Syracuse, N. Y.

When the base-metal surface of zinc, aluminum and magnesium diecastings falls short of requirements for appearance, corrosion, or wear resistance, chromium plating offers the best answer for many applications. Chromium may be applied directly, or on top of copper plus nickel, depending on coating thickness required and the need for abrasion resistance.

Cost of the plated finish on a part is influenced by a number of design factors such as section thickness, shape or contour, fillets and radii, location of parting line, type of lettering, design of ribs and provision for racking. Surfaces to be polished should be adapted to machine polishing, if possible. Shape of the part and racking method should permit free dissipation of gases evolved in the plating process. Design must recognize the limitations of the "throwing power" of the bath, or limited ability to plate uniformly in recesses. Parts must be free from shrinkage cracks, cold shuts, porosity and other surface defects.

Materials

Of the more common diecasting metals, zinc alloys are easiest to plate, Zamak 3 and Zamak 5 being best, with Zn 6 also satisfactory. Aluminum and magnesium alloys offer greater difficulty, poor adherence of the plate often leading to high rejection rates and increased plating costs. The problem of plating aluminum is made easier by precoating the parts with zinc by dip or

spray. Cleanliness of metal tends to reduce surface defects and cut plating costs. The Certified Zinc Plan used by most diecasting suppliers assures purity of metal.

Chromium may be plated directly to zinc diecastings to improve wear resistance. Maximum plating thickness is about 0.0002 in. But most requirements in chromium plating of diecastings are met by a multiple plating process which coats the parts first with copper, then with nickel, and finally with chromium. Copper adheres well to the zinc base, nickel readily plates on copper and provides a good base for chromium. Result is good adherence of the chromium, with the nickel adding to the corrosion resistance.

Plating Thickness

Service conditions dictate the thickness of coating required. Decorative plating requires the thinnest coating, wear resistance the heaviest deposit. Intermediate thicknesses are satisfactory for corrosion resistance. Many applications involve all three functions, as in automobile door handles and surgical instruments.

ASTM Standard B 142-55 calls for a minimum thickness for underplate of copper-plus-nickel of:

Service	*Thickness, in.*
Outdoor	0.00120
Intermediate	0.00075
Indoor	0.00050

Copper undercoating must be at least 0.00020 in., with nickel a minimum of 0.00050 in. for outdoor service and 0.00030 in. for all other service. Minimum thickness of chromium is 0.000010 in. Heavier coatings are recommended for severe corrosive or abrasive service.

Preparation of Parts

Much of the expense of plating is incurred in preparation: removing flash, grinding, polishing and buffing.

Zinc diecastings require special surface preparation before chromium plating. Surface discontinuities are eliminated by buffing and occasional spot polishing. If castings are so small that buffing is impractical, they are smoothed by tumbling, but finish is not as good. In any case, surfaces must be free of sponginess, die markings, porosity and other defects such as cold shuts and pinholes.

Section Thickness

Heavy sections, or thick pads or bosses encourage pitting and structural defects that impair the plated finish or add to the cost of preparation. Unusually heavy sections tend to become porous when the casting shrinks as it solidifies.

Coring can be used to turn an objectionable heavy section into a satisfactory wall, Fig. 1. Gear hubs often can be thinned down by coring, without loss of strength.

Thin sections are desirable because they are relatively stronger and cool faster in the die, which makes for high production rates and low unit costs. On the other hand, section thicknesss should be heavy enough to insure a smooth, even surface. Sections that are too thin may not fill the die properly, or they may warp or deform during ejection. Also, the casting must have sufficient body to support plating and to withstand the strain of buffing and polishing.

Recommended minimum wall thicknesses for zinc diecastings are 0.030 in. for average and 0.060 in. for larger parts. The corresponding aluminum thicknesses are 0.050 in. and 0.080 in.

With abrupt changes in section size, the freezing pattern tends to cause warping, and accentuates the difficulties accompanying heavy sections. Changes in section therefore should be gradual to avoid porosity and improve plating characteristics.

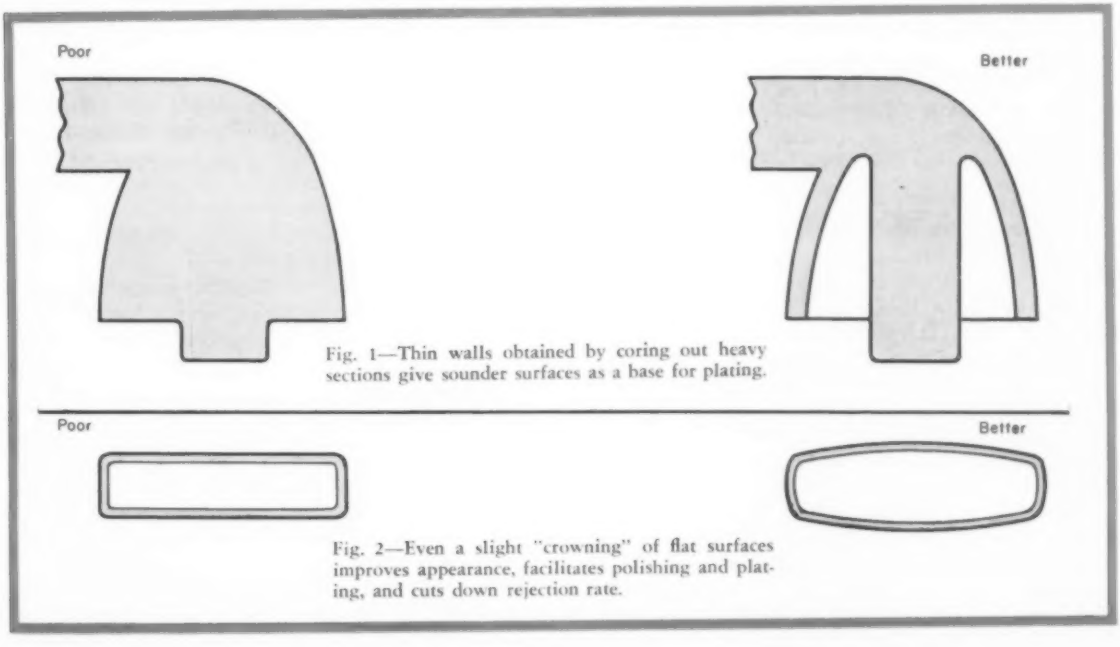


Fig. 1—Thin walls obtained by coring out heavy sections give sounder surfaces as a base for plating.

Fig. 2—Even a slight "crowning" of flat surfaces improves appearance, facilitates polishing and plating, and cuts down rejection rate.

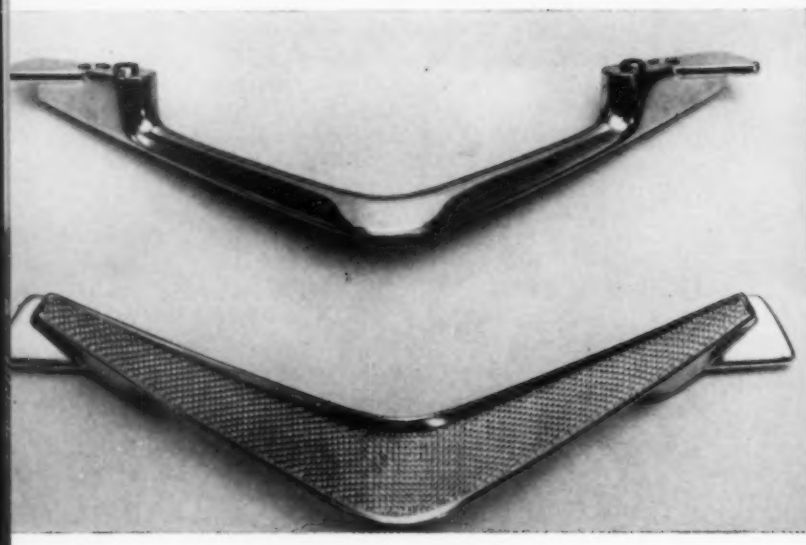


Fig. 3—Two automobile trunk handles. Below, serrations break continuity of reflecting surface, making defects less noticeable. Large reflecting surfaces, above, tend to emphasize defects.

Fig. 4—Parallel ribbing acts as a guide in buffing this zinc die cast body trim. Continuous fillets aid in appearance. In the radiator grill, buffing direction is determined by design of openings.

Surfaces

Large, flat surfaces tend to exaggerate small imperfections that would not be objectionable otherwise. A small degree of crowning aids good casting and often produces a more desirable appearance. Greater crowning or curvature improves appearance as well as aiding in avoiding sharp external angles. For example, a cigarette lighter with the section shown at left in Fig. 2 was redesigned with a rounded cross-section to improve the appearance, simplify finishing operations and reduce rejections. Light is reflected only along a narrow band, rather than across the entire surface at once.

If surface ornamentation is permissible, large flat surfaces can be broken up to avoid reflection problems. Introduction of a slight pattern, raised beads, shallow ribbing, or other serrated design, Fig. 3, is desirable where it will not interfere with casting and buffing. Ribs and beads should run in the direction the buffing wheels will move over the surface, Fig. 4.

Fillets and Corners

Good practice both in fillets and in outside corners pays off in reduced cost per piece, easier finishing and fewer rejects, as well as in longer die life. Main point is to use generous radii and fillets where possible. Rounded surfaces are stronger and easier to cast as well as being easier to clean, buff and finish.

Sharp edges and projections are troublesome because of high current concentration during the plating operation, and are easily broken during buffing. Also, plating will wear off more readily at sharp edges in normal use.

Sharp inside corners are difficult to polish. Fillets should be more generous at points where bending may introduce stress concentration. Bosses and cast studs should always have good fillets.

Small fillets at strengthening ribs promote good plating and make for easier polishing. Fillets also ease the transition from heavier to thinner sections, Fig. 5, and improve the grain structure and produce a better surface for plating. In addition, they facilitate die construction and speed up casting ejection, with additional cost savings.

Fillets and radii as large as practical usually simplify buffing operations. Where sharper edges are needed, even a slight radius or bevel (breaking the edge) is helpful. Minimum fillet size is 0.060 in.; corner radius should not be less than 0.015 in.

When sharp edges or flat surfaces are necessary, Fig. 6, it is better to provide extra metal in the casting, which is later machined off to the desired dimension.

Parting Lines

Design of the parting line should take flash removal into consideration. A minor design change that has little or no effect on function or appearance of the part may avoid special trimming equipment. Transferring the parting line from one surface to another sometimes makes for easier trimming, buffing and finishing, reducing the cost of the part.

Sharp corners at the die parting line will usually be broken or rounded off during flash removal. A radius at the parting line means that the die must be parted at the large dimension where the radius ends. This may make the parting line more noticeable, or place it where flash is more difficult to remove. If the parting line is on a surface that must be machined anyway, the cost of removing the flash will be reduced.

Beading the parting line, Fig. 7, will reduce finishing costs by facilitating flash removal while preserving the basic surface. Die trimming can be used to do a cleaner job, with a light polish along the narrow bead line. A parting line bead also serves to blend a slight mismatching of mating parts.

Fig. 5—Generous fillets and radii make for sound diecastings and easier finishing in this mirror bracket. Note large fillet in the transition from thin to heavy section. Splines are die cast in the mirror mounting hole.

Lettering

One of the advantages of diecasting is the ease with which lettering, trade marks, numerals, instructions, scales and diagrams can be cast in. While lettering and other marks are best cast on surfaces nearly parallel to the parting line, they can be located on other surfaces as long as undercuts are not required, or the lettering does not interfere with ejection of the casting.

If the lettering is raised, it can be finished simply without the need for a separate paint-filling operation. It also costs less than depressed lettering. If the lettering must not project beyond the casting surface, the background behind the lettering may be depressed so that the tops of the letters are flush. This type of lettering can be readily finished by conventional plating methods. A bright polish on the surface of the lettering offers a good contrast with the unbuffed finish below.

Nameplates and instructions can be cast-in to eliminate the cost of mounting separate plates or decals. Scales on dials or instruments are accurately cast and readily finished. Numerals or letters set against a simple, contoured background are less costly than open letters hanging from the background.

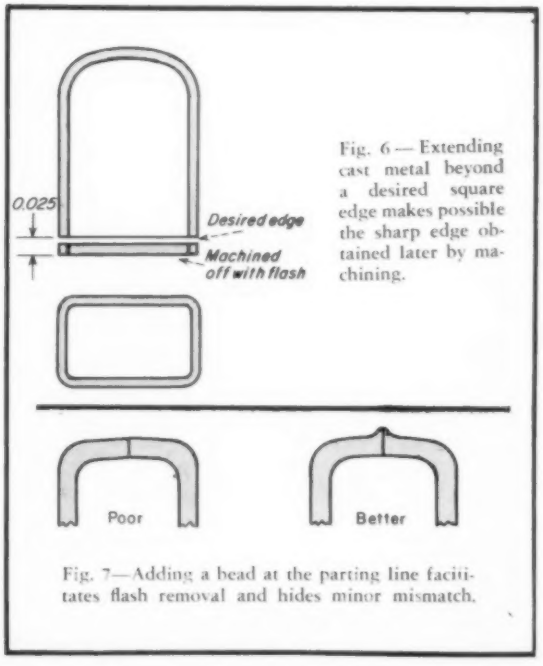


Fig. 6 — Extending cast metal beyond a desired square edge makes possible the sharp edge obtained later by machining.

Fig. 7—Adding a bead at the parting line facilitates flash removal and hides minor mismatch.

Provision for Racking

Since proper racking of parts is essential to good plating, provision for racking (means of holding the part with a hook or support) should be designed-in where possible to avoid special racks and supports. Racking bosses with holes for plating hooks may be desirable or short wires or thin projections may be cast in and snapped off later. When tapped holes are used for support, the plating current may damage the threads.

If the method of racking forms cavities that collect plating solution, drain holes should be provided. Deep concave areas may require special racking to produce uniform current density in the recess. Racking should also arrange for escape of gas. If gas collects in a pocket or sweeps up the side of the part, bubbles break contact between electrolyte and metal surface causing poor appearance or peeling.

EDITOR'S NOTE: Design recommendations for a good plating also make sound diecastings. "Redesign for Die Castings," January 1956 jage 156 covers properties of diecasting alloys, use of integral fastenings, desirability of thin sections and methods for strengthening with ribs, size of fillets and angles, coring to reduce subsequent machining, use of inserts. "Design Tips for Changing to Die Castings," Mid-October 1954 page D-12, covers design tips for bosses, inclined walls and base plate design; approximate dimensional limits for die castings in various alloys. "The Diecasting Process," (by the same author) was reviewed in March 1957 page 227.

Other Decorative Platings

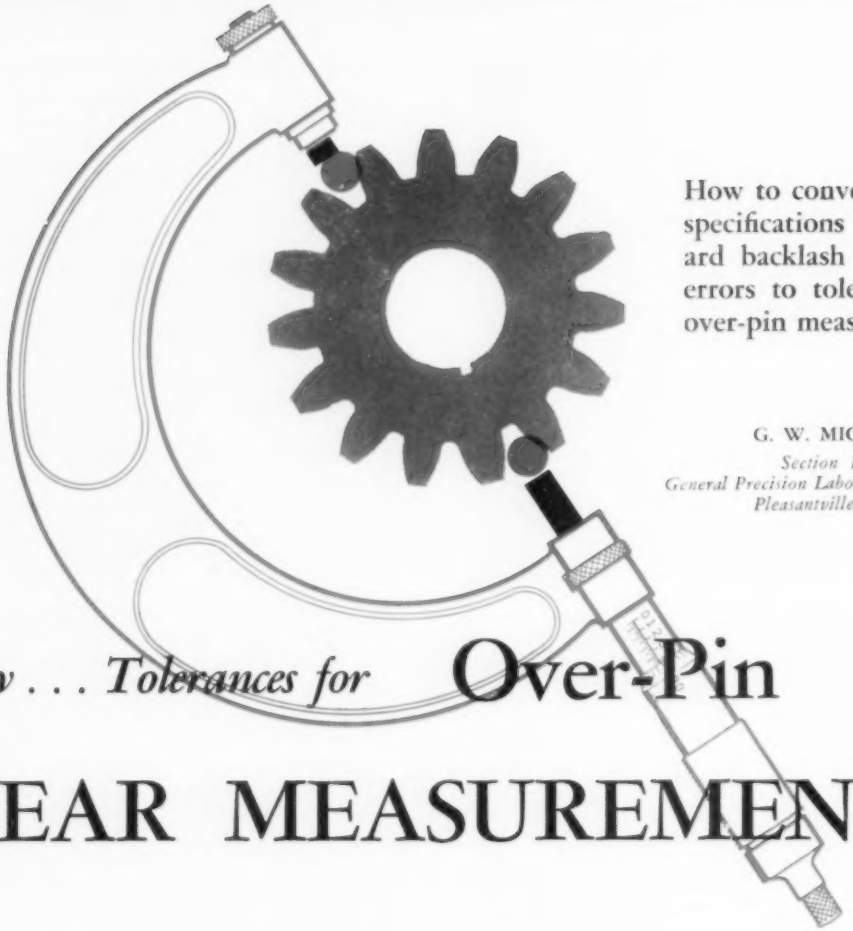
Brass may be substituted for chromium in the last stage of the plating process, producing a decorative, bright, gold-like effect. Exact shade of color can be varied over a wide range.

Silver, gold or other metals can be plated on zinc diecastings after preplating with copper and nickel.

Black coatings or platings can be produced on zinc diecastings by electrochemical methods giving a lustrous black surface. Other color effects are obtainable by proprietary processes.

Chromium and color may be combined by masking off the sections to be left unplated with chromium, and then coloring them in a subsequent operation. Color areas are normally protected with clear lacquer.

These finishes, primarily decorative, are generally applied to products used indoors and where mechanical wear is not involved.



How to convert AGMA specifications for standard backlash and tooth errors to tolerances for over-pin measurements.

G. W. MICHALEC
Section Head
General Precision Laboratory Incorporated
Pleasantville, N. Y.

Now . . . Tolerances for Over-Pin GEAR MEASUREMENTS

Assuming proper tooth contour and spacing, the tooth thickness and gear concentricity are the important design specifications requiring tolerances to assure desired performance. Tooth width and concentricity combined can be checked with the variable-center-distance method described in an earlier article, "Methods for Specifying Precision of Spur Gears," November 1956 page 135. This article also discusses the limitations of the caliper method for direct measurement of tooth thickness and the dial indicator method for concentricity.

Over-pin measurement is another method for quickly measuring the tooth thickness. Two accurately ground pins of proper diameter are placed at opposite positions and the distance across the pins measured with a micrometer. For inspection of gears with odd number of teeth, the pins are placed in tooth spaces as nearly opposite as possible. The measurement is then compared with nominal values given in various tables, such as, "The New American Machinist Handbook," page 4-53, *McGraw-Hill Book Company*, New York; or the American Gear Manufacturers Association (AGMA), Standard 236.04. These tables, however, do not include tolerances.

Over-pin measurements have these advantages: (1) Gears purchased in small quantities can be quickly inspected without need for special equipment. (2) Over-pin dimensions are easily specified on a gear drawing and just as easily interpreted by the inspection department. (3) Tooth thickness of a gear can be checked during the machining process while the gear is still on the arbor.

Main limitations are that the method does not take into consideration the concentricity of the gear bore with the pitch circle nor the accuracy of the tooth profile.

Because of these limitations, AGMA specifications emphasize the use of the variable-center-distance method in which the test gear is rotated tightly in mesh with a master gear or rack of known accuracy. The resulting variations in the center distance are then recorded and analyzed. For this method, AGMA has established permissible tolerances for various classes of gears.

Although over-pin measurements are widely used, there are no standardized design tolerances for this method, thus limiting the use of this method in specifying gears. Many gear manufacturers have established their own tolerances, but this does not help the gear designer. Quite often the acceptance or rejection of a purchased gear is left to the discretion of the inspection department because there are no over-pin standards.

Solution is to set up a tolerance system for over-pin measurement that is equivalent to the AGMA tolerances in Tables I and II. But correlation between the two systems is not a simple matter. Tooth thickness directly affects backlash. Backlash, in turn, prevents jamming, over-loading and over-heating of gears. On the other hand, excessive backlash is objectionable if

TABLE I—PERMISSIBLE BACKLASH PER MESHED PAIR

From AGMA Standard 236.04—20° Pressure Angle

	Diametral Pitch	Backlash, In.
Class A	20 to 45	0.004 to 0.006
	46 to 70	0.003 to 0.005
	71 to 90	0.002 to 0.0035
Class B	20 to 60	0.002 to 0.004
	61 to 120	0.0015 to 0.003
	121 and finer	0.001 to 0.002
Class C	20 to 60	0.001 to 0.002
	61 to 120	0.0007 to 0.0015
	121 and finer	0.0005 to 0.001
Class D	No measurable backlash at any pitch	

Backlash values are understood to be backlash between two assembled gears at their tightest point of mesh. Backlash will be increased when the low points of runout are in contact.

TABLE II—AGMA STANDARD FOR TOTAL AND TOOTH-TO-TOOTH COMPOSITE ERRORS

From AGMA Standard 236.04 for fine pitch gears

Class		Total Composite Error, in.	Tooth-to-Tooth Composite Error, in.
Commercial	1	0.006	0.002
	2	0.004	0.0015
	3	0.002	0.001
	4	0.0015	0.0007
Precision	1	0.001	0.0004
	2	0.0005	0.0003
	3	0.00025	0.0002

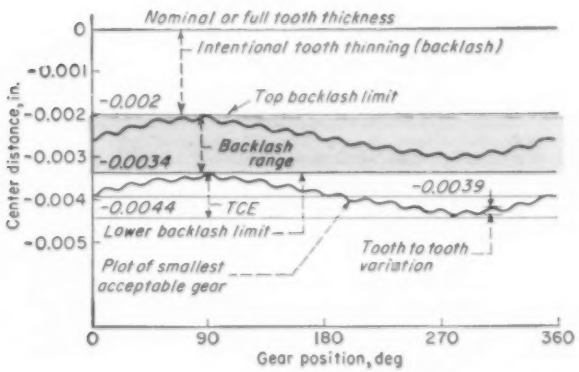


Fig. 1—Variations in center distance between a test gear and master gear. The AGMA standards specify the permissible backlash (in color) and total composite error (TCE). Over-pin measurements cannot detect TCE; are difficult to correlate with AGMA standards.

the drive frequently reverses, if there is an over-running load or if high positional accuracy in the gear train is required.

The backlash information of Table I can be accurately converted into equivalent over-pin measurements by means of standard formulas. Unfortunately such a conversion is not correct because Table I states that the values are for the tightest point of mesh. Once the gears are mounted and rotated, there may be additional backlash because of eccentricity between the bore and pitch circle.

To account for eccentricity, AGMA has established classes of gears based on the Total Composite Error (TCE) as shown in Table II. A complete gear specification includes a number for the TCE quality and a letter for the backlash class, for example: Precision 1-B; Commercial 3-A. To insure accuracy, the effect of TCE must be analyzed and included in the correlation.

Comparison with AGMA Specifications

Typical variations in center distance, or "plot," of a gear with tooth-to-tooth errors and bore eccentricity are shown in Fig. 1. Assuming that a 48-pitch gear with a 20° pressure angle per AGMA Class Precision 1-A is desired, the permissible tolerances from Tables I and II are: TCE = 0.001; backlash per meshed pair = 0.003 to 0.005. Therefore, backlash per gear = 0.0015 to 0.0025.

Equivalent change in center distance for the upper limit of the backlash tolerance is

$$\Delta C.D = \frac{B}{2 \tan \phi} = \frac{0.0015}{2(0.364)} = 0.002$$

This establishes the top limit of the largest acceptable gear because all backlash values in Table I are for gears at their tightest point of mesh. Using the same formula, the lower limit is 0.0034. Fig. 1 shows the plots of two gears having a TCE equal to 0.001, with one gear at the upper level of the backlash level and the other at the lower level. In other words, the TCE specifications restrict the amplitude of the plot, and the backlash values establish the position of the plot with respect to the nominal datum line.

One problem in correlating this system to over-pin measurements is that the gear at the lower level can have a maximum variation in center distance of 0.0044 in. and still be acceptable. But because the over-pin measurement cannot detect TCE, it would be incorrect to establish tolerances based on the maximum variation. Therefore, the average value for the smallest acceptable gear, −0.0039 in this case, is used as the lowest limit for converting to over-pin measurements, and the total acceptable range is from −0.002 to −0.0039. This range is illustrated in Fig. 2 and the limits designated as the "theoretical" maximum and "theoretical" minimum.

There are still some gears, however, that may pass inspection by the over-pin method within these limits and still be rejected when inspected by AGMA standards. For example, referring again to Fig. 2, a gear at the top limit can also have some TCE which cannot be detected by over-pin gaging and part of its plot would fall above the −0.002 line. (*next page, please*)

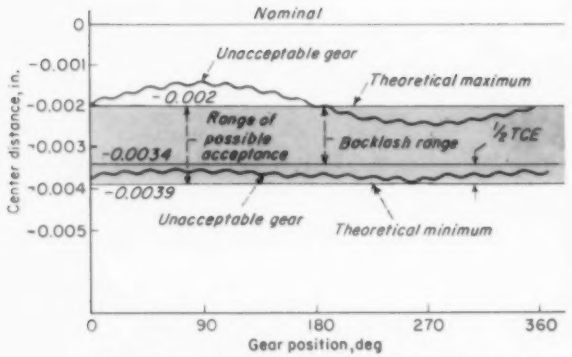


Fig. 2—Theoretical tolerance range (in color) for over-pin measurements is equal to AGMA backlash range plus one-half TCE. However, certain gears unacceptable to AGMA standards may get through inspection.

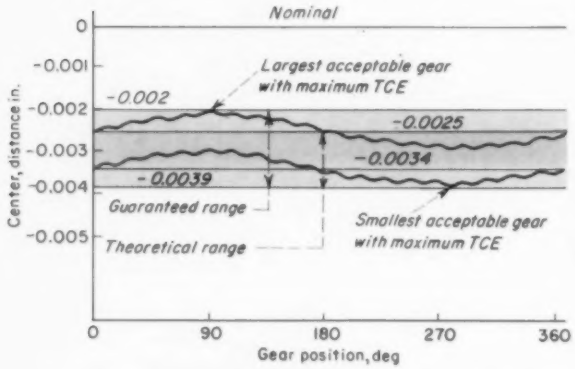


Fig. 3—Narrower range of tolerances (in color) than theoretical range can almost "guarantee" that a test gear is within AGMA specifications.

On the lower end of the size range, gears which fall just within the lower limit but have low TCE, would fail to pass the AGMA standards because the high points of their plots would not reach the minimum value of −0.0034 as specified by the backlash designation.

To avoid this situation, the limits should be reduced to −0.0025 and −0.0034; in other words, from the largest permissible value of the high point minus ½ maximum TCE, to the minimum value for the high point. This narrower range, shown graphically in Fig. 3, may then be considered as the "guaranteed" range for over-pin measurements. However, even this narrower range is valid only if the TCE does not exceed its limits, and since this cannot be a certainty, the literal meaning of "guarantee" means "highly probable."

All gears fulfilling the class requirements per guaranteed over-pin measurements will also fall within class limits on a center-distance check provided the TCE is within the allowable maximum. The converse is not true: all gears passing the center distance test will not fall within the guaranteed over-pin limits. But the exceptions are few and the guaranteed tolerances offer best standards. (text continued on page 199)

TABLE III—VALUES OF

20-PITCH, T=0.07854

Precision Class	T_a	T_b	T_c	T_d
1-A	0.07654	0.076176	0.07554	0.075176
1-B	0.07754	0.077176	0.07654	0.076176
1-C	0.07804	0.077676	0.07754	0.077176
1-D	0.07854	.....	.....	0.078176
2-A	0.07654	0.076358	0.07554	0.075358
2-B	0.07754	0.077358	0.07654	0.076358
2-C	0.07804	0.077858	0.07754	0.077358
2-D	0.07854	.....	.....	0.078358
3-A	0.07654	0.076449	0.07554	0.075449
3-B	0.07754	0.077449	0.07654	0.076449
3-C	0.07804	0.077949	0.07754	0.077449
3-D	0.07854	.....	.....	0.078449

24-PITCH, T=0.06545

Precision Class	T_a	T_b	T_c	T_d
1-A	0.06345	0.063086	0.06245	0.062086
1-B	0.06445	0.064086	0.06345	0.063086
1-C	0.06495	0.064586	0.06445	0.064086
1-D	0.06545	.....	.....	0.065086
2-A	0.06345	0.063268	0.06245	0.062268
2-B	0.06445	0.064268	0.06345	0.063268
2-C	0.06495	0.064768	0.06445	0.064268
2-D	0.06545	.....	.....	0.065268
3-A	0.06345	0.063359	0.06245	0.062359
3-B	0.06445	0.064359	0.06345	0.063359
3-C	0.06495	0.064859	0.06445	0.064359
3-D	0.06545	.....	.....	0.065359

32-PITCH, T=0.04909

Precision Class	T_a	T_b	T_c	T_d
1-A	0.04709	0.046726	0.04609	0.045726
1-B	0.04809	0.047726	0.04709	0.046726
1-C	0.04859	0.048226	0.04809	0.047726
1-D	0.04909	.....	.....	0.048726
2-A	0.04709	0.046908	0.04609	0.045908
2-B	0.04809	0.047908	0.04709	0.046908
2-C	0.04859	0.048408	0.04809	0.047908
2-D	0.04909	.....	.....	0.048908
3-A	0.04709	0.046999	0.04609	0.045999
3-B	0.04809	0.047999	0.04709	0.046999
3-C	0.04859	0.048499	0.04809	0.047999
3-D	0.04909	.....	.....	0.048999

TOOTH THICKNESS FOR COMPUTING OVER-PIN TOLERANCES

48-PITCH, T = 0.03272

Precision Class	T_a	T_b	T_c	T_d
1-A	0.03122	0.030856	0.03022	0.029856
1-B	0.03172	0.031356	0.03072	0.030356
1-C	0.03222	0.031856	0.03172	0.031356
1-D	0.03272	.....	.....	0.032356
2-A	0.03122	0.031038	0.03022	0.030038
2-B	0.03172	0.031538	0.03072	0.030538
2-C	0.03222	0.032038	0.03172	0.031538
2-D	0.03272	.....	.....	0.032538
3-A	0.03122	0.031129	0.03022	0.030129
3-B	0.03172	0.031629	0.03072	0.030629
3-C	0.03222	0.032129	0.03172	0.031629
3-D	0.03272	.....	.....	0.032629

64-PITCH, T = 0.02454

Precision Class	T_a	T_b	T_c	T_d
1-A	0.02304	0.022676	0.02204	0.021676
1-B	0.02379	0.023426	0.02304	0.022676
1-C	0.02419	0.023826	0.02379	0.023426
1-D	0.02454	.....	.....	0.024176
2-A	0.02304	0.022858	0.02204	0.021858
2-B	0.02379	0.023608	0.02304	0.022858
2-C	0.02419	0.024008	0.02379	0.023608
2-D	0.02454	.....	.....	0.024358
3-A	0.02304	0.022949	0.02204	0.021949
3-B	0.02379	0.023699	0.02304	0.022949
3-C	0.02419	0.024099	0.02379	0.023699
3-D	0.02454	.....	.....	0.024449

72-PITCH, T = 0.02182

Precision Class	T_a	T_b	T_c	T_d
1-A	0.02082	0.020456	0.02007	0.019706
1-B	0.02107	0.020706	0.02032	0.019956
1-C	0.02147	0.021106	0.02107	0.020706
1-D	0.02182	.....	.....	0.021456
2-A	0.02082	0.020638	0.02007	0.019888
2-B	0.02107	0.020888	0.02032	0.020138
2-C	0.02147	0.021288	0.02107	0.020888
2-D	0.02182	.....	.....	0.021638
3-A	0.02082	0.020729	0.02007	0.019979
3-B	0.02107	0.020979	0.02032	0.020229
3-C	0.02147	0.021379	0.02107	0.020979
3-D	0.02182	.....	.....	0.021729

80-PITCH, T = 0.01964

Precision Class	T_a	T_b	T_c	T_d
1-A	0.01864	0.018276	0.01789	0.017526
1-B	0.01889	0.018526	0.01814	0.017776
1-C	0.01929	0.018926	0.01889	0.018526
1-D	0.01964	.....	.....	0.019276
2-A	0.01864	0.018458	0.01789	0.017708
2-B	0.01889	0.018708	0.01814	0.017958
2-C	0.01929	0.019108	0.01889	0.018708
2-D	0.01964	.....	.....	0.019458
3-A	0.01864	0.018549	0.01789	0.017799
3-B	0.01889	0.018799	0.01814	0.018049
3-C	0.01929	0.019199	0.01889	0.018799
3-D	0.01964	.....	.....	0.019549

96-PITCH, T = 0.01636

Precision Class	T_a	T_b	T_c	T_d
1-A	.....	.....	.....	.....
1-B	0.01561	0.015246	0.01486	0.014496
1-C	0.01601	0.015646	0.01561	0.015246
1-D	0.01636	.....	.....	0.015996
2-A	.....	.....	.....	.....
2-B	0.01561	0.015428	0.01486	0.014678
2-C	0.01601	0.015828	0.01561	0.015428
2-D	0.01636	.....	.....	0.016178
3-A	.....	.....	.....	.....
3-B	0.01561	0.015519	0.01486	0.014769
3-C	0.01601	0.015919	0.01561	0.015519
3-D	0.01636	.....	.....	0.016269

120-PITCH, T = 0.01309

Precision Class	T_a	T_b	T_c	T_d
1-A	.....	.....	.....	.....
1-B	0.01234	0.011976	0.01159	0.011226
1-C	0.01274	0.012376	0.01234	0.011976
1-D	0.01309	.....	.....	0.012726
2-A	.....	.....	.....	.....
2-B	0.01234	0.012158	0.01159	0.911408
2-C	0.01274	0.012558	0.01234	0.012158
2-D	0.01309	.....	.....	0.012908
3-A	.....	.....	.....	.....
3-B	0.01234	0.012249	0.01159	0.011499
3-C	0.01274	0.012649	0.01234	0.012249
3-D	0.01309	.....	.....	0.012999

SYMBOLS

a — Radius of pins inserted between teeth. Standard pins are based on the equation $a = \frac{1}{2}(1.728/P)$

B — Backlash per pair of gears as specified by AGMA letter class and listed in Table I.

C — Maximum total composite error (TCE) as specified by AGMA quality class and listed in Table II.

M — Over-pin measurements

N — Number of teeth

P — Diametral pitch

R — Standard pitch radius, $R = N/P$

R_b — Base circle radius, $R_b = R \cos 20°$

R_c — Radial distance to center of pin

T — Full tooth thickness at standard radius R, $T = 1.5708/P$

T_x — Desired tooth thickness at standard radius R.

ϕ — Pressure angle = 20°

ϕ_1 — Pressure angle at center of pin

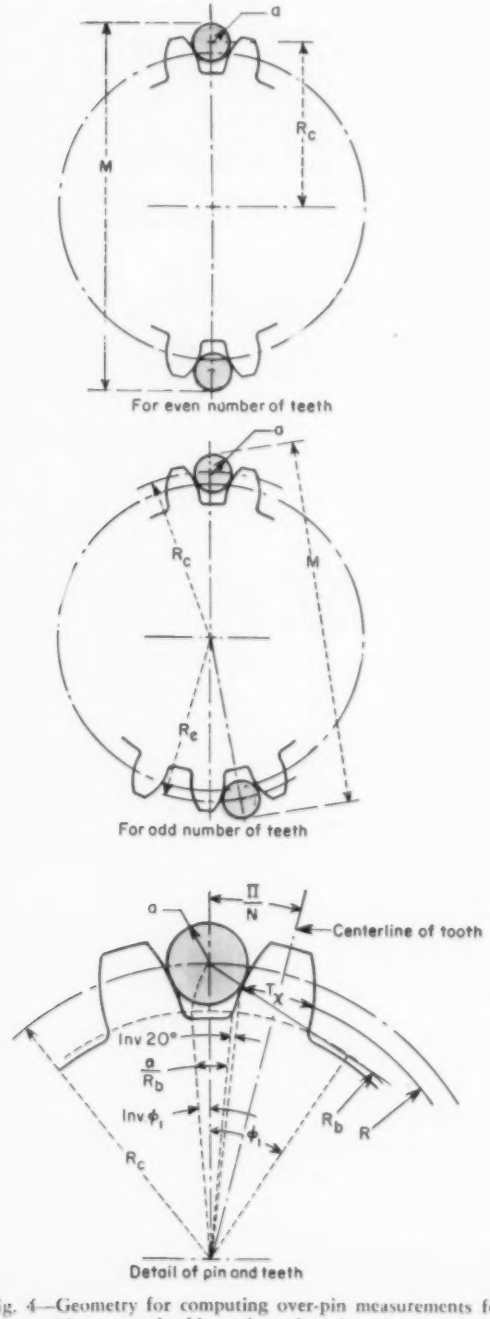


Fig. 4—Geometry for computing over-pin measurements for gears with even and odd number of teeth.

Table IV—Over-pin Measurements for Various Values of Tooth Thicknesses (as obtained from a computer)

Class: AGMA Precision 1A
Pitch: 32
Pin Diameter = 0.054

No. of Teeth	Theoretical Maximum M_a	Guaranteed Maximum M_b	Guaranteed Minimum M_c	Theoretical Minimum M_d
5	0.2158	0.2151	0.2140	0.2133
6	0.2557	0.2550	0.2538	0.2530
7	0.2814	0.2807	0.2794	0.2787
8	0.3188	0.3180	0.3167	0.3159
9	0.3457	0.3450	0.3436	0.3429
10	0.3816	0.3809	0.3795	0.3787
11	0.4094	0.4086	0.4072	0.4064
12	0.4444	0.4436	0.4422	0.4414
13	0.4727	0.4719	0.4705	0.4697
14	0.5071	0.5063	0.5049	0.5040
15	0.5358	0.5350	0.5336	0.5327
16	0.5698	0.5690	0.5675	0.5667
17	0.5988	0.5980	0.5965	0.5956
18	0.6325	0.6316	0.6301	0.6293
19	0.6617	0.6608	0.6593	0.6585
20	0.6951	0.6942	0.6927	0.6918
21	0.7245	0.7237	0.7221	0.7213
22	0.7577	0.7568	0.7553	0.7544
23	0.7873	0.7864	0.7849	0.7840
24	0.8203	0.8194	0.8179	0.8170
25	0.8500	0.8491	0.8476	0.8467
26	0.8829	0.8820	0.8804	0.8795
27	0.9127	0.9118	0.9103	0.9094
28	0.9454	0.9445	0.9430	0.9421
29	0.9754	0.9745	0.9729	0.9720
30	1.0080	1.0071	1.0055	1.0046
31	1.0380	1.0371	1.0355	1.0346
32	1.0705	1.0696	1.0681	1.0672
33	1.1006	1.0997	1.0981	1.0972
34	1.1331	1.1322	1.1306	1.1297
35	1.1633	1.1623	1.1608	1.1598
36	1.1956	1.1947	1.1931	1.1922
37	1.2258	1.2249	1.2233	1.2224
38	1.2582	1.2573	1.2557	1.2547
39	1.2884	1.2875	1.2859	1.2850
40	1.3207	1.3198	1.3182	1.3173
41	1.3510	1.3501	1.3485	1.3476
42	1.3832	1.3823	1.3807	1.3798
43	1.4136	1.4127	1.4111	1.4101
44	1.4458	1.4449	1.4432	1.4423
45	1.4761	1.4753	1.4736	1.4727
46	1.5083	1.5074	1.5058	1.5048
47	1.5387	1.5378	1.5362	1.5353
48	1.5708	1.5699	1.5683	1.5673
49	1.6013	1.6004	1.5987	1.5978
50	1.6334	1.6324	1.6308	1.6299
51	1.6639	1.6629	1.6613	1.6604
52	1.6959	1.6950	1.6933	1.6924
53	1.7264	1.7255	1.7238	1.7229
54	1.7584	1.7575	1.7558	1.7549
55	1.7890	1.7880	1.7864	1.7854
56	1.8209	1.8200	1.8183	1.8174
57	1.8515	1.8506	1.8489	1.8480
58	1.8834	1.8825	1.8809	1.8799
59	1.9140	1.9131	1.9115	1.9105

Computing the Tolerance Ranges

Relationships between tooth thickness and over-pin measurements are based on the geometry of Fig. 4:

For odd-numbered teeth

$$M = 2\left[a + R_c \cos\left(\frac{90^\circ}{N}\right)\right] \quad (1)$$

For even-numbered teeth

$$M = 2[a + R_c] \quad (2)$$

where

$$R_c = R\left(\frac{\cos 20^\circ}{\cos \phi_1}\right) \quad (3)$$

and the value of ϕ_1 is obtained from:

$$\text{inv}\,\phi_1 = \frac{T_x}{2R} + \frac{a}{R_b} - \frac{\pi}{N} + \text{inv}\,20^\circ \quad (4)$$

By substituting the full tooth thickness T of a particular gear for T_x in Eq (4), a value for the involute of ϕ_1 is obtained, the angle of which can be found from a table of involutes. This will give the nominal value for M from Eq (1) or (2) which can be checked with existing tables of over-pin measurements.

Four Reduced Tooth Thicknesses

To obtain over-pin measurements that are equivalent to the AGMA standards, four reduced tooth thicknesses are substituted for T_x, values of which are obtained from

T_a = Theoretical maximum = $T - 1/2\ B_{\min}$

T_b = Guaranteed maximum = $T - 1/2\ (B_{\min} + 0.728C)$

T_c = Guaranteed minimum = $T - 1/2\ B_{\max}$

T_d = Theoretical minimum = $T - 1/2\ (B_{\max} + 0.728C)$

These values are substituted for T_x in Eq (4) to obtain the four limits of over-pin measurements: M_a, M_b, M_c, and M_d, listed in descending order of magnitude. The combination M_a and M_d constitute the upper and lower limits of the "theoretical" range and the combination M_b and M_c the "guaranteed" narrower range.

In using this data, one would be highly confident of a gear being correct per class if within the narrower limits. If the measurement only falls within the wider extreme limits, the gear is "probably" within class requirements. This can only be verified by rolling on a variable-center fixture to check if the TCE is within the permissible range for that class.

Tables for Computations

Values of tooth thicknesses T_a to T_d, to be used in computing the over-pin dimensions are listed by class in Table III. The actual dimensions M_a to M_d consist of hundreds of tables similar to the typical one shown in Table IV, and therefore are not presented here because of space limitations. This is because the diametral pitch cannot be eliminated from the equations. Although the AGMA tolerances are variable, they remain fixed over a range of pitches for a given gear class and it is not possible to condense the data in terms of one diametral pitch and divide by the pitch for other values. This results in a great number of possible tables when one considers the range of pitches and cross combinations of AGMA backlash and accuracy classes.

Complete tables corresponding to the tooth thicknesses in Table III have been compiled at the General Precision Laboratory. Because of the length and repetition of the calculations, this was only made possible through use of digital computers and the author is indebted to the members of the GPL Analysis Section. Those wishing to verify their calculations for over-pin tolerances against GPL's data can do so by contacting the author.

EDITOR'S NOTE: Other phases of gear design have been discussed in these recent articles:

"Epicyclic Gears for Control Mechanisms," February 1957 page 194. Unusual arrangements of epicyclic gears systems with only two gears for control, counting and other light-duty high-reduction mechanisms.

"Stress Cycles in Planitary Gears," January 1957 page 219. Charts and formulas for calculating the stress cycles that a particular gear tooth receives during desired life.

"Measurement and Control of Chatter in Gear Drives," December 1956 page 168. Chatter analysis by instrument; equations for computing speed variations and eccentricity; recommendations for gear reducers and drive motors.

"Wear Life of Aluminum Gears," September 1956 page 160. Modification of Hertz's theoretical equations to conform to actual test results; analytical procedure for estimating probable life; comparison of anodized and unanodized gears.

"Finished-Forged Gear Teeth Now Used in German Autos," May 1956 page 180. Description of a new German gear manufacturing process requiring no machining for average tolerances.

"Lubrication of High-Capacity Gear Drives," May 1956 page 173. Method for calculating lubrication and cooling requirements; how to select components including pumps, strainers, relief valves and coolers.

"Design Charts for Precision Gears," October 1955 page 209. Tables and charts for minimum face width to drive low-torque applications.

"Bearing Loads on Gear Shafts," June 1955 page 209. Simple, fast and accurate method for calculating direction and magnitude of bearing loads.

"Surface Endurance Limits for Gear and Cam Materials," Mid-October 1955 page E3. Data based on surface wear tests to help determine safe wear and load carrying capacity.

"Inserts for Plastic Gears" Mid-October 1955 page E6. Design hints for using nylon inserts.

"Avoiding Gear Tooth Interference," November 1954 page 207. Simple method using design charts for calculating maximum diametral pitch that can be used without under cutting or using non-standard tooth forms.

"Formula for Epicyclic Gear Train of Large Reduction," December 1954 page 213. System using six gears to obtain high reduction.

"Whole Number Solutions of Indeterminate Equations for Gearing," May 1954 page 198. Description of little-known method using diaphantine equations for determining number of teeth for each gear of a train.

"Effects of Size on Gear Design Calculations," April 1954 page 129. How size influences accuracy of angular transmission, manufacturing tolerances, backlash, center distance and contact ratio.

"Balanced Design for Case-Hardened Gears," March 1954 page 209. Use of statistical methods in the automotive field help analyze gear tooth failures due to bending, pitting and scoring.

"Intermittent Spur Gears," February 1954 page 175. Method for avoiding gear tooth interference and high deflections.

16 Latch, Toggle and

Diagrams of basic latching and quick-release mechanisms.

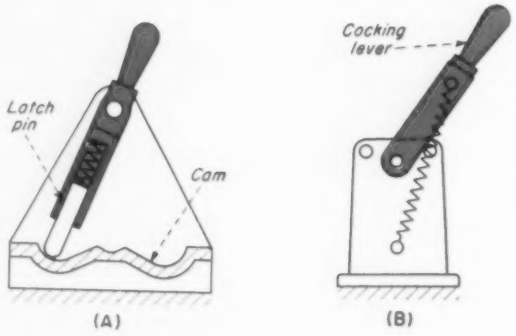
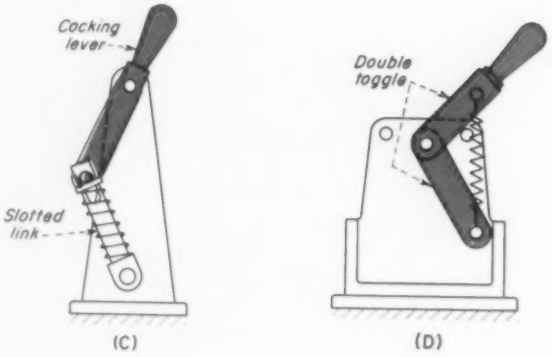


Fig. 1—Cam-guided latch (A) has one cocked, two relaxed positions. (B) Simple over-center toggle action. (C) Over-center toggle with slotted link. (D) Double toggle action is often used in electrical switches.



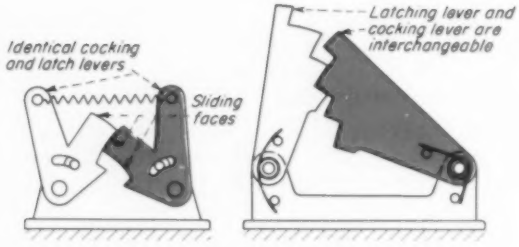


Fig. 2—Identically shaped cocking lever and latch (A) allow functions to be interchangeable. Radii of sliding faces must be dimensioned for mating fit. Stepped latch (B) has several locking positions.

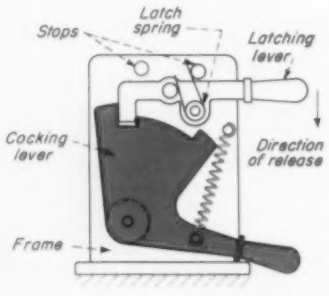


Fig. 3—Latch and cocking lever spring-loaded so latch movement releases cocking lever. Cocked position can be held indefinitely. Studs in frame provide stops, pivots or mounts for springs.

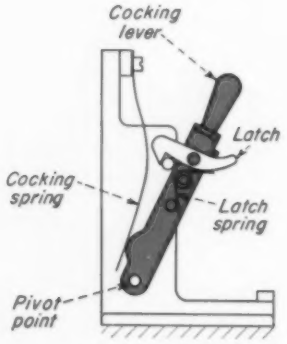


Fig. 4—Latch mounted on cocking lever allows both levers to be reached at same time with one hand. After release, cocking spring initiates clockwise lever movement, then gravity takes over.

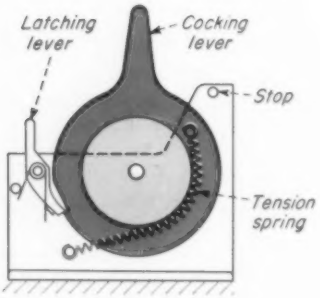


Fig. 5—Disk-shaped cocking lever has tension spring resting against cylindrical hub. Spring force thus alway acts at constant radius from lever pivot point.

Trigger Devices

SIGMUND RAPPAPORT

Project Supervisor, Ford Instrument Company
Adjunct Professor of Kinematics, Polytechnic Institute of Brooklyn

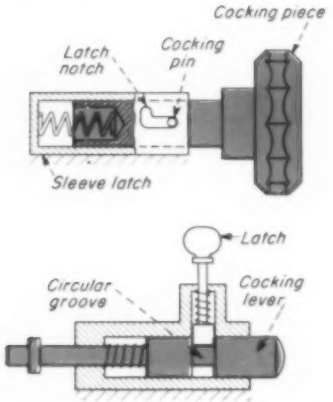
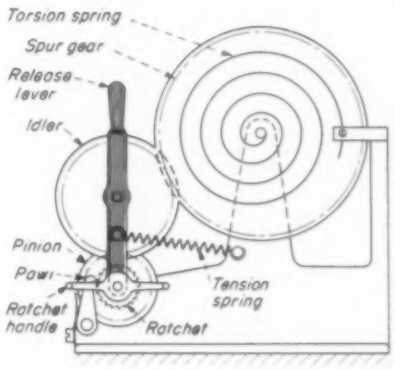


Fig. 6—Sleeve latch (A) has L-shaped notch. Pin in shaft rides in notch. Cocking requires simple push and twist action. (B) Latch and plunger use axial movement for setting and release. Circular groove needed if plunger can rotate.

Fig. 7—Geared cocking device has rachet fixed to pinion. Torsion spring exerts clockwise force on spur gear; tension spring holds gear in mesh. Device wound by turning ratchet handle counter-clockwise which in turn winds torsion spring. Moving release-lever permits spur gear to unwind to original position without affecting ratchet handle.



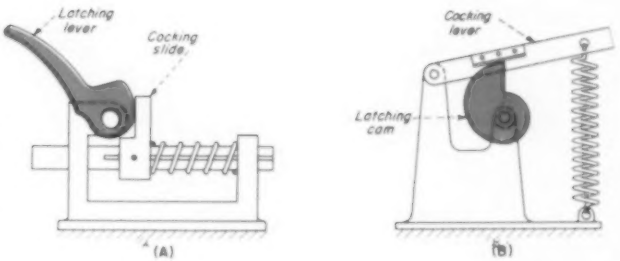


Fig. 8—In over-center lock (A) clockwise movement of latching lever cocks and locks slide. Release requires counter-clockwise movement. (B) Latching-cam cocks and releases cocking lever with same counter-clockwise movement.

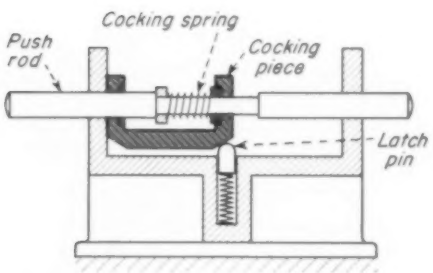


Fig. 9—Spring-loaded cocking piece has chamfered corners. Axial movement of push-rod forces cocking piece against spring-loaded ball or pin set in frame. When cocking builds up enough force to overcome latch-spring, cocking piece snaps over to right. Action can be repeated in either direction.

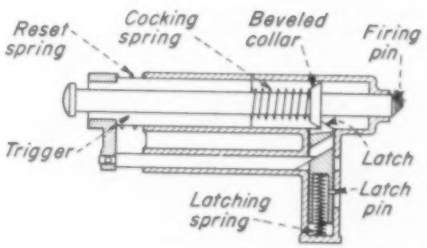
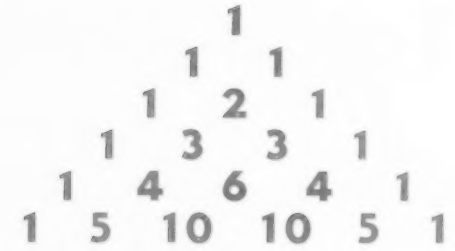


Fig. 10—Firing-pin type mechanism has bevelled collar on pin. Pressure on trigger forces latch down until it releases collar, when pin snaps out under force of cocking spring. Reset spring pulls trigger and pin back. Latch is forced down by bevelled collar on pin until it snaps back after overcoming force of latch spring. (Latch pin retains latch if trigger and firing pin are removed.)

Data based on material and sketches in AWF und VDMA Getrieblaetter, published by Ausschuss fuer Getriebe beim Ausshuss fuer Wirtschaftiche Fertigung, Leipzig, Germany.

Here's a new short-cut for



Powers of Numbers

This ingenious and speedy computation gives precise answers without reference to tables or slide rule.

WILL J. WORLEY
Urbana, Illinois

If you were asked to compute $(203)^4$ or $(977)^{-3}$, your first impulse would be to hunt up a slide rule, a handbook or a desk calculator. Both of these computations, however, can be performed quickly and accurately with the binomial expansion and Pascal's triangle.

The novel idea presented here arises from the manner in which the terms a and b are expressed in the relation:

$$(a+b)^n = \sum_{r=0}^{r=n} C_r^n \, a^{(n-r)} \, b^r \qquad (1)$$

where $C_r^n = \dfrac{n(n-1)\,(n-2)\,.\,.\,.\,.\,(n-r+1)}{r!}$

Let $a = 10^p c$, $b = 10^q d$ with $1 \le c \le 9$, $1 \le d \le 9$, hence:

$$(a+b)^n = (10^p c + 10^q d)^n = 10^{pn}\,(10^{(p-q)}c + d)^n \qquad (2)$$

Now let $(p-q) = t =$ a positive integer, $p \ge (q+1)$. Expanding, the following relation is obtained:

$$10^{pn}(10^t c + d)^n = 10^{pn}\,[10^{tn}c^n + n10^{t(n-1)}c^{(n-1)}d +$$

$$\frac{n(n-1)}{2!}\,10^{t(n-2)}c^{(n-2)}d^2 + \ldots$$

$$+ \frac{n(n-1)\,(n-2)\,\ldots\,(n-r+1)}{r!}\,10^{t(n-r)}c^{(n-r)}d^r + \ldots$$

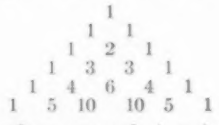
$$+ \frac{n(n-1)}{2!}\,10^{tn}c^2d^{(n-2)} + n10^{t}cd^{(n-1)} + d^n] \qquad (3)$$

As an example, let $p = +1$, $q = 0$, $t = +1$, $n = 4$, then:

$$\cdot(10c+d)^4 = 10^4c^4 + 4\cdot10^3c^3d + 6\cdot10^2c^2d^2 + 4\cdot10cd^3 + d^4$$

where it is known that the coefficients which multiply the respective terms are the coefficients in the fourth-power horizontal row of Pascal's triangle presented below.

Pascal's triangle can be built up by adding ones along the diagonals and adding the two terms in the row above to obtain the coefficients in a particular row. Thus, in the sixth row corresponding to $n = 5$, the 10 is obtained by adding the 4 and 6 from the row above:



In practice, the above example is written as follows:

c^4	$c^3 \cdot d$	$c^2 \cdot d^2$	$c \cdot d^3$	d^4
1	4	6	4	1

where the indicated products are formed. These are then multiplied by the corresponding coefficient. Thus, if $c = 1$ and $d = 2$, then:

$$(12)^4 = \begin{array}{ccccc} 1 & 2 & 4 & 8 & 16 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ 1 & 4 & 6 & 4 & 1 \end{array}$$

$$\begin{array}{cccccc} & 2 & 3 & 1 & & \\ 1 & 8 & 4 & 2 & 6 & \text{multiplication of products} \end{array}$$

$$2\quad 0,\ 7\quad 3\quad 6 \text{ answer}$$

From working with more complex examples than this, it has been found desirable to perform the multiplication from left to right. When a two-digit number results from the multiplication, carry the second digit to the next higher decimal place at the left. Following this step, do the addition in the usual way and get the answer at once.

Applying Eq. 3, it can be shown that there are $(t-1)$ zeros between coefficients in the binomial expansion.

Now consider an example in which $p = +3$, $q = +1$, $t = +2$, $n = +2$, $c = 5$, $d = 3$,

$$(5030)^2 = 10^2\,(503)^2$$

$$10^2 \begin{bmatrix} 25 & 15 & 9 \\ 1 & 02 & 01 \end{bmatrix} = 25{,}300{,}900$$

When there are no zeros between coefficients, i.e., $t = +1$, with the coefficients equal to or exceeding 10, only one digit may appear in each column and the product such as 80 must have the 8 carried over to the next column to the left.

Let $p = +1$, $q = 0$, $t = +1$, $n = +5$, c = 2, and $d = 1$:

$$(21)^5 = \begin{array}{cccccc} 32 & 16 & 8 & 4 & 2 & 1 \\ 1 & 5 & 10 & 10 & 5 & 1 \end{array}$$

$$\begin{array}{cccccc} 8 & 8 & 4 & 1 & & \\ 32 & 0 & 0 & 0 & 0 & 1 \end{array}$$

$$4{,}0 \quad 8 \quad 4, \quad 1 \quad 0 \quad 1$$

Contrast the above with the case in which $p = +2$, $q = 0$, $t = +2$, $n = +5$, c = 2, and $d = 1$.

$$(201)^5 = \begin{array}{cccccc} 32 & 16 & 8 & 4 & 2 & 1 \\ 1 & 05 & 10 & 10 & 05 & 01 \end{array}$$

$$32 \quad 8{,}0 \quad 80, \quad 40 \quad 1{,}0 \quad 01$$

Here, two decimal places are available for each coefficient, hence a three-digit product would be needed to require a number to be carried over into an adjacent column to the left.

Thus far all values of d have been positive. It may be verified from Eq 3, that if d is negative, every other coefficient is negative, hence the procedure may be applied as illustrated below. Let $p = +1$, $q = 0$, $t = +1$, $n = 4$, c = 3, and $d = -1$.

$$(10c\text{-}d)^4 = + \begin{pmatrix} c^4 & & c^2 \cdot d^2 & & d^4 \\ 1 & 0 & 6 & 0 & 1 \end{pmatrix} - \begin{pmatrix} & c^3 \cdot d & & c \cdot d^3 & \\ 0 & 4 & 0 & 4 & 0 \end{pmatrix}$$

$$(29)^4 = (30-1)^4 = + \begin{bmatrix} 81 & & 9 \cdot 1 & & 1 \\ 1 & 0 & 6 & 0 & 1 \end{bmatrix}$$

$$+ [\ 81 \quad 5, \quad 4 \quad 0 \quad 1\ ]$$

$$- \begin{bmatrix} & 27 \cdot 1 & & 3 \cdot 1 & \\ 0 & 4 & 0 & 4 & 0 \end{bmatrix}$$

$$- [\ 1 \quad 08, \quad 1 \quad 2 \quad 0\ ]$$

$$= 707{,}281$$

Letting $\eta = -n = +1, +2, +3$, etc, the procedure may be applied to negative exponents, Hence:

$$(a+b)^{-\eta} = (10^p c + 10^q d)^{-\eta} = 10^{-q\eta}\,(10^{(p-q)}\,c + d)^{-\eta}$$

where, as before, $(p-q) = t$, or:

$$10^{-q\eta}\,(10^t c + d)^{-\eta} = 10^{-q\eta}\left[10^{-t\eta}\,c^{-\eta} - \eta 10^{-t(\eta+1)} c^{-(\eta+1)} d + \frac{\eta(\eta+1)}{2!}\,10^{-t(\eta+2)} c^{-(\eta+2)} d^2 + \cdots + (-1)^r \left(\frac{\eta(\eta+1)\cdots(\eta+r-1)}{r!}\right) 10^{-t(\eta+r)} c^{-(\eta+r)} d^r + \cdots\right] \tag{4}$$

Coefficients for $n = +1, +2, +3$, and $+4$, for the rth term in the expansion may be written:

$$C_r^{(-1)} = (-1)^r$$

$$C_r^{(-2)} = (-1)^r\,(r+1)$$

$$C_r^{(-3)} = (-1)^r\,\frac{(r+1)\,(r+2)}{2!}$$

$$C_r^{(-4)} = (-1)^r\,\frac{(r+1)\,(r+2)\,(r+3)}{3!}$$

Extracting the factor 10^{-t} from Eq 4 yields:

$$(10^{-p\eta})\left[c^{-\eta} - \eta 10^{-t} c^{-(\eta+1)} d + \frac{\eta(\eta+1)}{2!}\,10^{-2t} c^{-(\eta+2)} d^2 + \cdots\right] \tag{5}$$

as an example, let $p = +2$, $q = 0$, $t = +2$, $\eta = +3$:

$$\frac{1}{(10^2 c + d)^3} = 10^{-6}\,[c^{-3} - 3 \cdot 10^{-2} c^{-4} d + 6 \cdot 10^{-4} c^{-5} d^2 - 10(10^{-6}) c^{-6} d^3 + \cdots]$$

Note that the coefficients which multiply the respective terms, $C_r^{(-3)}$ above, are the coefficients in the third diagonal row of Pascal's triangle reading from upper left to lower right.

While the general case appears above, for reciprocals where c is different from unity, the process becomes extremely complex. Also, unless the values of d are negative, the subtraction process discussed above for positive exponents is necessary.

The above example may be written thus for d negative:

$$10^{-6}\left[\begin{array}{cccc} c^{-3} & & c^{-5} \cdot d & & c^{-6} \cdot d^2 & & c^{-6} \cdot d^3 \\ 1 & & 03 & & 06 & & 10 \end{array}\right]$$

where, letting c = 1, and $d = -3$:

$$\frac{1}{(97)^3} = \frac{1}{(100-3)^3} = 0.000001 \begin{array}{ccc} 3 & 9 & 27 \\ 03 & 06 & 10 \end{array}$$

$$\begin{array}{c} 2 \\ = 0.0000001095470 \\ = 0.000000109567 \end{array}$$

Note that there are $(p \cdot \eta - 1)$ zeros in front of the first coefficient and $(t-1)$ zeros between successive coefficients.

Next consider $p = +1$, $q = 0$, $t = +1$, $\eta = +2$, c = 1, $d = -2$:

$$\frac{1}{(8)^2} = \frac{1}{(10-2)^2} = 0.01 \begin{array}{ccccc} 2 & 4 & 8 & 16 & 32 \\ 2 & 3 & 4 & 5 & 6 \end{array}$$

$$\begin{array}{ccccccc} & & & 1 & & & \\ & & 1 & 3 & 8 & 9 & \\ 0.01 & & 4 & 2 & 2 & 0 & 2 \\ 0.01 & & 5 & 6 & 1 & 9 & 2 \end{array}$$

Again with $p = +1$, $q = -1$, $t = +2$, $\eta = +1$, c = 1, $d = -5$

$$\frac{1}{9.5} = \frac{1}{(10-0.5)} = 0.1 \begin{array}{cccc} 5 & 25 & 125 & 625 \\ 01 & 01 & 01 & 01 \end{array}$$

$$\begin{array}{cccccc} & & & 1 & 6 & \\ 0.1 & & 05 & 25 & 25 & 25 \\ 0.1 & & 05 & 26 & 31 & 25 \end{array}$$

To illustrate the procedure when d is a positive number, consider $p = +2$, $q = 0$, $t = +2$, $\eta = +2$, c = 1, $d = 4$:

$$\frac{1}{(100+4)^2} = \begin{array}{ll} \left[\begin{array}{cccc} & & 16 & \\ 0.0001 & 00 & 03 & 00 \end{array}\right] = & 0.0001004800 \\ - \left[\begin{array}{cccc} & 4 & & 64 \\ 0.0000 & 02 & 00 & 04 \end{array}\right] = & -0.0000080256 \\ \hline & 0.0000924544 \end{array}$$

The procedures outlined above for positive exponents can be applied to the multinomial expansion in the same

manner. Specifically, the trinominal expansion will be used as an example:

$$(10^u c+10^v d+e)^2 = 10^{2u}c^2+10^{2v}d^2+e^2+2 \cdot 10^u 10^v cd+ 2 \cdot 10^u ce+2 \cdot 10^v de$$

if u = 2, and v = 1,

$$(100c+10d+e)^2 = 10^4c^2+2 \cdot 10^3 c \cdot d+10^2(d^2+2ce) + 2 \cdot 10de+e^2$$

This example is written as follows

c^2	cd	d^2+2ce	de	e^2
1	2	1	2	1

Thus if c = 4, d = 3, and e = 2, then

$(432)^2$ =	16	12	25	6	4
	1	2	1	2	1
	2	2	1		
	16	4	5	2	4
	18	6	6	2	4

Hence for numbers involving more than two non-zero ciphers, where the multinomial theorem is necessary, the procedure is beyond the scope of ordinary memory. Its usefulness for rapid computations, where no computing equipment or tabulated values are at hand, is thus limited to numbers with two non-zero ciphers.

The process is so simple, involving only a knowledge of the binomial expansion and the method of building up Pascal's triangle, that it is recommended for serious consideration as a supplemental method of presenting multiplication in our high schools. As a matter of fact, shortly after this procedure was developed in June, 1955, it was presented to Dr. Shuji Taira, who has now returned to Kyoto University, Kyoto, Japan. Dr. Taira stated that while he had never seen the reciprocal expansions, he had learned a method of multiplication in high school in Japan which is outlined below.

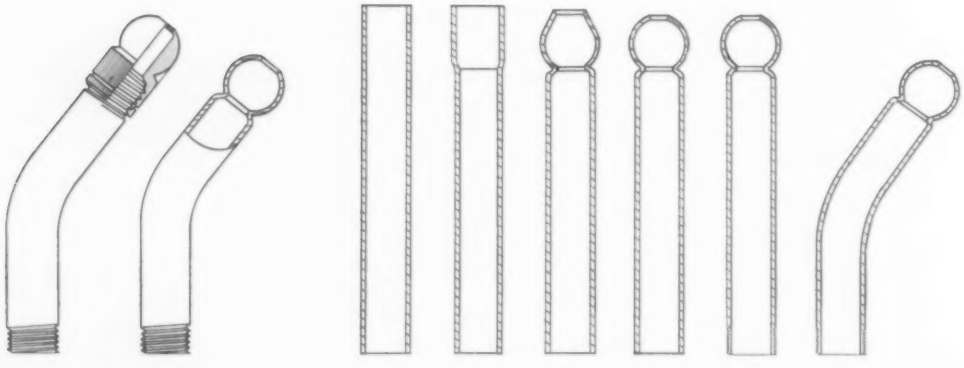
1	1,000,000
3×4	120,000
$(104)^3$ = 3×16	4,800
1×64	64
	1,124,864

The difference between the Japanese method and that proposed in this paper is in the saving in time from automatic decimal-point location for each coefficient.

It is hoped that this approach will stimulate further study and perhaps result in the development of procedures which will simplify certain types of digital or desk-computer techniques as well as save time where long-hand computation is necessary.

SPHERICAL SWIVEL SEAT

Press Formed in Five Operations



ERNEST J. URBAS
Supt., Tool and Die Department, The Guarantee Specialty Co.

New method of fabrication for brass shower head arms produces a formed spherical swivel seat integral with the arm. Formerly the arm consisted of two pieces, a bent heavy wall tube threaded on both ends, and a swivel ball machined from solid bar. In addition to providing a spherical seat for the spray head the swivel ball also had a constriction or orifice to limit flow. Each part was chrome plated and then assembled with a water-tight fit, with one or two threads still showing producing an unsightly appearance.

Redesigned based on a one-piece tubular part formed the spherical end and orifice in five press operations, starting with a cut-off piece of brass tubing. Since machined threads are not needed, tubing wall thickness is reduced by half. New part has better appearance and lighter weight, as well as lower cost. The assembly operation is eliminated along with critical gaging and inspection of the threads.

Mr. Urbas' idea for a press-formed shower arm was a winning entry in the John Woodman Higgins Redesign Award Competition sponsored by Pressed Metal Institute.

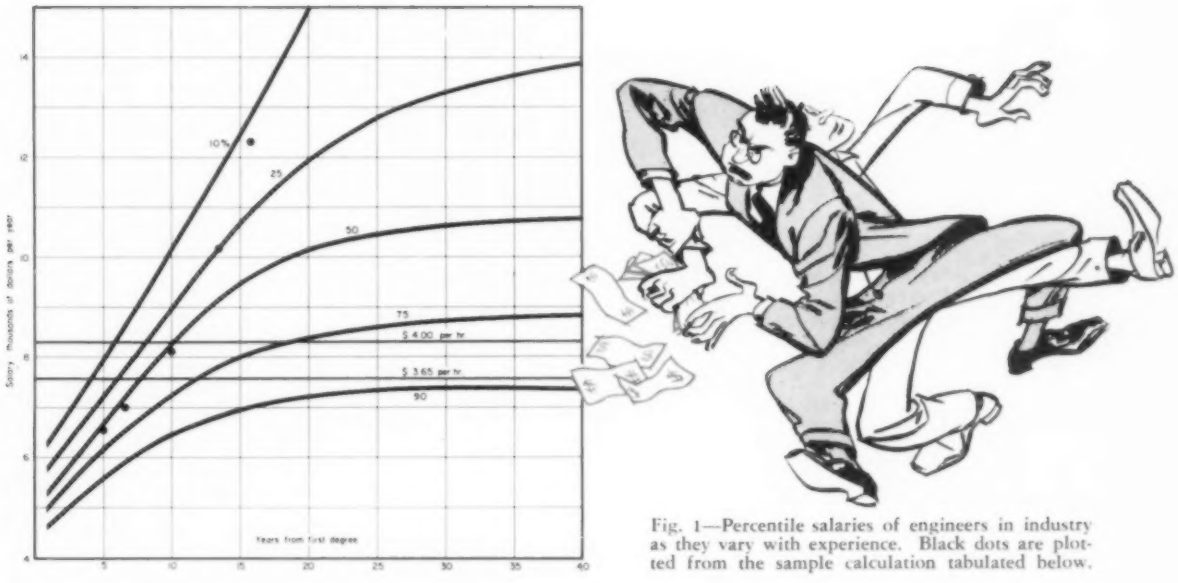


Fig. 1—Percentile salaries of engineers in industry as they vary with experience. Black dots are plotted from the sample calculation tabulated below.

Readers Reply to the Question . . .

ARE YOU PAID WHAT YOU'RE WORTH?

In March, we published a condensation of a paper by Dr. Edward B. Peck giving the results of the Engineers Joint Council salary study and suggesting a salary administration policy based on the study. Almost immediately letters started to pour in, praising, blaming or just plain philosophizing. Engineers are thinking people and what they think is well worth listening to—if you can get them to talk . . . Here are some of their thoughts. Most of these letters have been condensed somewhat to save space and avoid repetition. Most of the writers preferred to remain anonymous, so to be consistent we have omitted all names and company affiliations.

TO THE EDITOR

. . . when making a study of your Fig. 1 [reproduced above] the questions which naturally arose were:

1. How am I doing?
2. How did I do? (and am I making progress?

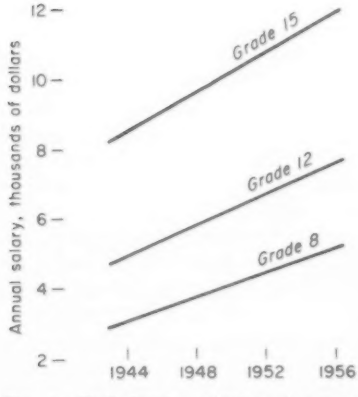


Fig. 2—Civil Service salaries. A correction factor may be calculated according to the ratio $F = 1956\ \text{Salary}/19?\ \text{Salary}$.

SAMPLE CALCULATION

Year	Actual Salary	Correction Factor	Equiv. 1956 Salary	Yrs. from degree
1945	4,500	1.45	6,500	5
1947	5,000	1.40	7,000	7
1950	6,800	1.20	8,100	10
1953	9,700	1.05	10,100	13
1956	12,300	1.00	12,300	16

The first question is easy to answer by plotting one's 1956 salary on the chart. However, the second is not quite so easy, since these curves apply only to 1956. I devised a system of obtaining correction factors to correct past annual earnings to equivalent 1956 earnings. The easiest data to use were increases in Civil Service salaries as plotted in Fig. 2.

The correction factor F is the ratio of 1956 Civil Service minimum to the minimum Civil Service salary at any year in question. Curves were then determined for the various Civil Service grades as shown in Fig. 3. If data were available on the median and various percentile groups for all engineers

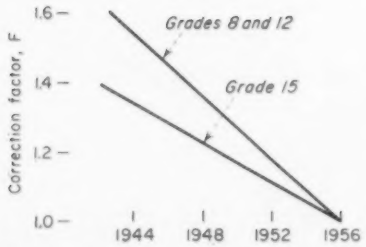


Fig. 3—Approximate correction factors based on Civil Service salaries. Actual salary at any given year times F equals equivalent 1956 salary which may be plotted on Fig. 1.

perhaps better correction factors could be found.

Then by applying the correction factor most applicable for that year, as shown in the example, it is possible to plot the results and estimate an individual's performance. This plot of points is superimposed on Fig. 1.

Another question closely associated with this article could be stated: Is it better to stay with one organization or to gain breadth of experience by moving? I would be interested to know what the statistics show as well as what representative experienced executives have to say. Most organizations emphasize length of service [but the good engineer] will leave for more fertile fields while the average-to-poor engineer will hang on for dear life.

What about supervisors?

TO THE EDITOR

It appears to me that Dr. Peck's article does not differentiate between length of service and extent of responsibility. . . . I assume that he has considered that an increasing supervisory and administrative load is expected in later years . . .

In our company I feel we have been remiss in training, evaluation of performance, and construction of a set of performance measures which would allow us to stimulate maximum productivity of our engineers. I think that the result of our delinquency in these matters is frequently a mediocre performance of our senior engineers, and they are buried with detail which should be carried on by their younger assistants. Before any mathematical formulation can be made of the gradient of salaries related to years of service, a clear procedure for increasing the value of the engineers should be established.

One other point concerns the problem of finding competent engineering supervisors. The best designers are frequently totally incapable of supervision and perhaps should not be given the problems of supervision since it distracts from their productivity. Nevertheless, in our industry, the best remuneration for engineering graduates goes to those men who not only are highly competent technically, with heavy emphasis on intiative and original thought, but who also are adequately schooled in human relations. . . .

TO THE EDITOR

Dr. Peck makes no clear statement defining the engineer classification referred to in the charts and tables. Do they include engineering supervisors, who, for the most part, are also engineers? If they do, the lot of the non-supervisory engineer is considerably bleaker than represented. About 8% of engineers are in a supervisory status (some surveys show as high as 11%). They reached this status through outstanding performance and are consequently paid on a different scale. [The survey included salaries of over 100,000 engineers of all grades. Supervisory status is the ambition of most engineers and indicative of ability and value to the company. As such, the higher salaries have a legitimate place in a study of this kind.—*Ed.*]

The integration from 22 to 65 years of engineers' income (for comparison with craftsmen's wages) presents the optimistic picture. Considering that craftsmen start their trade at 16-17 years, and make good money up to age 22, (the lower limit of integration) and that the engineer invests about $6,000 in his education during this period with no earnings, the earnings surplus comparison is about 20% too high in favor of the engineer.

I feel that it is high time that engineering management manage itself out of its troubles instead of blaming everyone else for the troubles that it itself produced. Consider the chief cry today of engineer shortage. Is this a true situation? Is there a shortage?

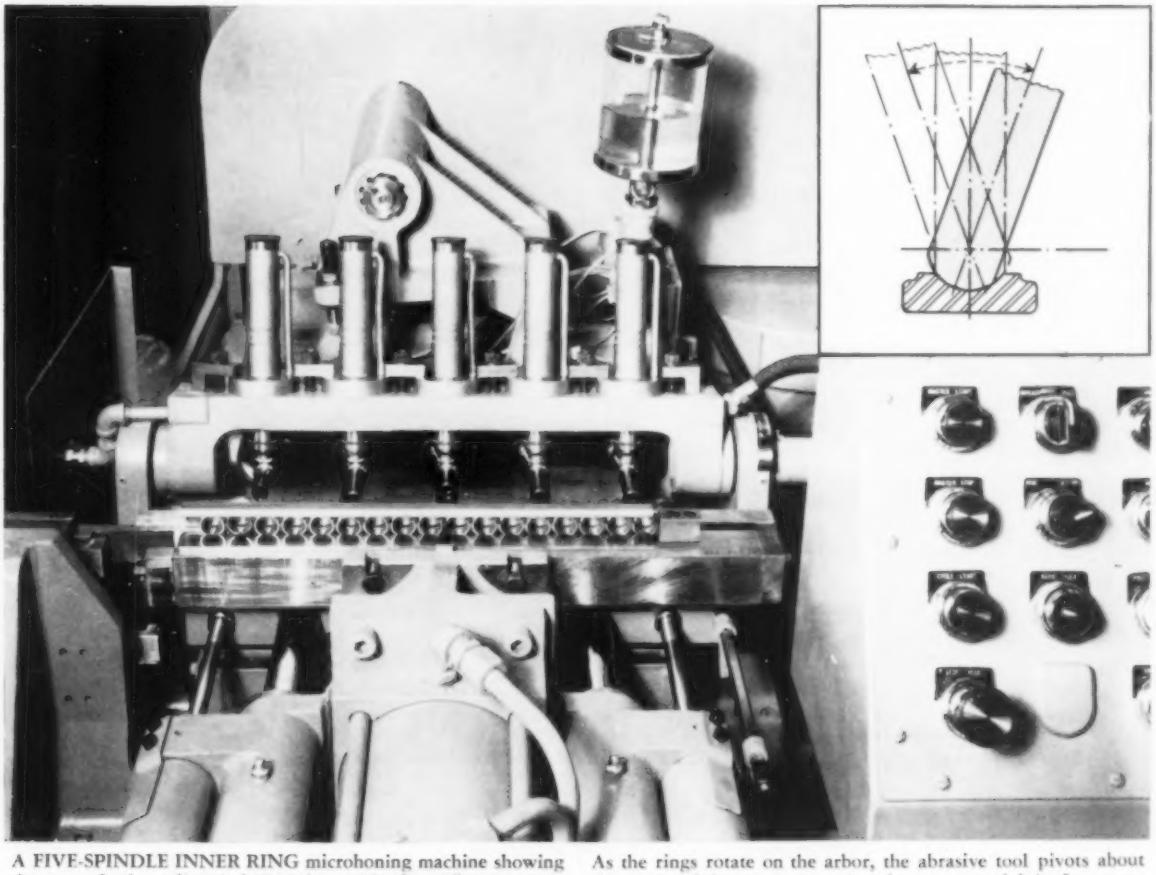
For the past five months I have been keeping a running check of

engineering jobs listed in *The New York Times* in three categories—(1) general defense design and development, (2) general established industry design and development, and (3) specific established industry. The check shows 70% in category (1), 4% in category (2), and 26% in category (3). Is there a real shortage of engineers in defense jobs? Yes! In industry? No!

Today every major engineering department in the country has graduate engineers doing non-technical, semi-technical, test and technician grade work under the guise of the title of engineer. Dr. Peck's charts and tables include these people and there isn't much hope for salary adjustment for these people. They will continue to be paid salaries of technicians and clerical help which lowers the engineering median curve and aggravates the engineering shortage. Companies and corporations pay for what a man does and not what he is or could be.

The engineering capacity of industry today could be increased 30%

(Continued on page 360)



A FIVE-SPINDLE INNER RING microhoning machine showing the tapered arbors directly below the tool bridge. The automatic loader and ejector is in front of the tool bridge. Outer rings are held in chucks that locate them from the OD and clamp on the side faces. Motions and cycling are the same as on the inner rings. Machines have 3 or 5 spindles depending on bearing size.

As the rings rotate on the arbor, the abrasive tool pivots about the center of the raceway arc (see inset, upper right). In a comparison test on the Waveometer, a commercial finish gave a reading of 6 on the low band and 1.5 on the high band. The microhoned surface produced a reading of 3 on the low band and on the high band a reading of 0.2 (microinches rms).

Bearing Raceways Improved; Production Automatized

Present ball bearing raceways, which are ground and hand polished, are considered precision bearings according to present standards. Using a Talyrond machine, which charts the geometric form of a surface, Micromatic Hone Corp., 8100 Schoolcraft Ave., Detroit 38, Mich., found that these surface profiles varied up to 200 microinches on a diameter. With a microhoning process, which generates a true geometric form and controlled surface finish, Micromatic was able to produce bearing raceways with surface variations of no more than 25 microinches. Furthermore, the process is accomplished automatically on multiple spindle machines.

These machines, considered the first in the anti-friction bearing industry, are designed with either 3 or 5 spindles, depending on the size of the bearing. The entire operation is automated, including automatic loading and ejection, automatic cycling, and automatic feeding of the abrasives. The machine stops automatically when it is necessary to replace the abrasive.

Production on a five spindle machine, finishing no. 8 inner bearings, is 500 rings per hr. Using three spindles for the outer rings of the same bearing, production is 240 rings per hr. This will vary with the size of the bearing and the condition of the rings as they come to the machines.

The machine generates a true geometric form that keeps the abrasive sticks self-dressing; abrades at a low velocity with controlled pressure; and has a float control in the tool that keeps the abrasive aligned with the neutral center of the raceway.

In operation—tapered arbors are used for the small inner rings, and end-clamping arbors for the larger sizes. The parts are pressed on the arbor, then pulled against a plate that lo-

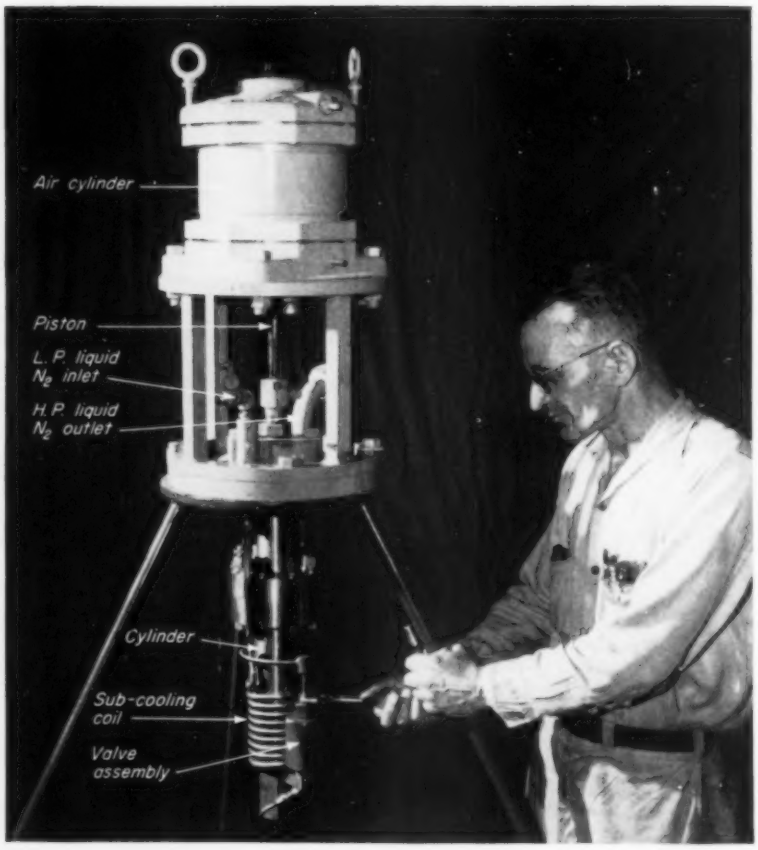
cates them in relation to the tools. Mounted on an oscillating bridge, the tools pivot about the true center of the raceway arc. As the ring rotates the abrasive sticks pass across the raceway track. During most of the timed cycle, the bridge oscillates rapidly to remove stock rapidly. The oscillation speed is automatically reduced to make a finished track.

This method of generating a true geometric form can be applied to the grinding and finishing of the balls, as well, with an eye towards increasing the number of applications of ball joints in automobiles and aircraft. Such a machine is now being tested in the automotive industry and is producing balls with a sphericity within 0.0002 in. Present techniques in this industry call for a variation in size of 0.004 in. Loads can be carried on a greater portion of the ball's surface. Presently, only a small area of the ball is used with the top knocked off. Using a greater area, ball joints can be designed with a big deflection and a decrease in galling.

Science Consultant To a City

Dr. I. M. Levitt of Philadelphia has a unique job: Science Consultant to the City of Philadelphia. The job is believed to be the first of its kind in the country, but Dr. Levitt feels that with the rapidly advancing scientific age, it will be just a matter of time before other cities follow suit.

Dr. Levitt's full-time job is Director of the Fel Planetarium of the Franklin Institute. The city job as science consultant is non-paying, and so far does not take too much of his time. For example, he acted as the representative of the city at the opening ceremonies of the recent International Atomic Exposition and Nuclear Congress. However, Dr. Levitt feels that the many engineers and scientists associated with the companies in the Philadelphia area have ideas which will help the city materially in its growth and operation. "With my office," Dr. Levitt says, "the citizen with an idea will get a hearing on it." "But, my job is to recommend. I do not become involved with contract details. I'm looking forward to the day when such a board of consultants will consist of 20 to 25 people."



10,000 Psi Nitrogen Gas for Missile, Rocket Engine Operation

With a capacity of 40,000 standard cu ft/hr, a 10,000 psi liquid nitrogen pump like the one shown here, is being developed to supply 10,000 psi nitrogen gas for rocket engine operation and charging containers for missile and aircraft "in-flight" pressurizing. The test model shown here has a 600 cfh capacity, is pneumatically driven, and uses a ¾ in. chrome plated stainless steel plunger. The completed unit will have two cylinders with 2½ in. dia plungers, and will be driven hydraulically at 24 strokes per min. Over-all dimensions of the pump are 3 x 3 x 6 ft high.

The cylinder has no liner material, but the plunger runs in a lower packing consisting of graphetized shredded Teflon rings placed between a series of Teflon washers. With a tolerance of 0.002 in. between the plunger and the cylinder, this lower packing absorbs the 10,000 lb pressure. The upper seal around the plunger is a rubber O-ring. Any leakage of nitrogen gas is drawn off here.

In operation the pump rests in an insulated container. The bottom flange of the air cylinder shown here, resting on the tripod, rests on the top of the container with the bottom portion of the pump submerged in liquid nitrogen. Stainless steel ball check valves are used, with a ¾ in. ball and a ⅜ in. hole. The seat also is stainless.

The pump discharges 10,000 psi liquid nitrogen which is sent through a water cooled vaporizer, converting the nitrogen to gaseous nitrogen at 5-10 standard cfm. The pump has an 80% volumetric efficiency.

Other suggested applications are: research on the properties of high-pressure gases; blowdown of hypersonic wind tunnels; nuclear research; bottle charging; and testing of valves, seals, fittings, and flexible tubing.

Looking Ahead in Automotive Design

Looking into the near future, automotive manufacturers have this to say about some of the new materials and processes to be used on automobiles still on the drawing boards:

Aluminum—will be used much more in automotive manufacturing than ever before. "In the next five years it will make much greater strides than it has in the past ten years," one said. Where?

The roof of an automobile. Cars will get much lower, and will be decorated with aluminum trim, and spruced up with colors. Roofs will no longer be flat; they will have dips and grooves, and will add to the car's appearance.

Transmissions this year, and very much next year, will be loaded with aluminum, both in castings and extruded forms. Transmissions also will have a lot of heat-treatable malleable iron.

It is not expected that aluminum will be used in the body proper. Headlight and taillight rims and insets will probably be made of aluminum in the near future, replacing zinc die castings and stainless steel.

Bumpers are being studied. One manufacturer is experimenting with bumpers that combine aluminum, stainless steel, and rubber. Another is working with aluminum bumpers which have vinyl plastic set into the areas of the bumper where much of the rubbing wear occurs.

All manufacturers still require some assurance on how the bumpers will be made. Extruded or cast? Will they have the structural strength necessary without being backed up with steel? What about a series of webs or ribs, extruded or cast on the back of the bumper to give higher stress ratings.

Alloy steels—now on the downgrade, will appear less and less in cars. In one make, only the differential and the springs use alloy steel. When air suspension is accepted by all the car makers, only the alloy steel differential will remain. There is a definite trend toward induction-hardened carbon steels or castings.

Automobile manufacturers say that the field of cold extrusions has never been sufficiently explored, and they expect great progress in that field.

Stainless steel—is coming into greater prominence, particularly in the luxury cars. The Cadillac Brougham, for $13,000, will have a stainless steel brushed-affect roof. Stainless also has a corner on the hub cap market. Aluminum is not being considered here, because of its vulnerability to the hydroxides found in areas where snow and ice clearance is a problem.

Plastics—glass fiber reinforced plastics, for example, is being considered for instrument panels. Many manufacturers like the material, but they want to use it in a liquid form, rather than in laid up lamination. Such a method has not been found.

Interiors of the cars are under close study, with replacements for inner door panels being considered. Big news in this respect is a method of molding fiberboard inside door panels. The arm rest is molded into the panel, and reports are that its strength is greater than sheet metal, and at a fraction of the cost. More research in this field, covering other areas where structural strength of the car body is not important, is expected.

Metal pipe and tubing will be scarce in the cars of the near future. Such piping for gasoline and oil will be replaced by nylons and other plastics. Inventory storage of such lines will be greatly simplified, as will the installation. Waste due to crushed or bent lines will be reduced.

Nylon for small gears is on the increase, particularly in oil pumps, water pumps, speedometers, etc.

Butyl rubber is being considered in tires. It has several advanages: no squeal on stops or curves; noise damping effect is good; and its stopping characteristics, because of a higher coefficient of friction, are about 25% better than other rubbers. However, because it does have better friction characteristics, it does wear out faster.

Polyurethanes in crashpads, seats, top of arm rests, and even weatherstripping around the doors and windows is interesting to the auto companies. Unlike rubber, it can be sewn through, and is tough and cheap. In the full foam construction of seats, it can be molded with the cover material. The material also is being considered for use as headliners.

Government Pays For Engineer Recruitment

Rep. James A Davis (D-Ga.) told Congress that a report made by Asst. Secretary of Navy, Albert Pratt, indicates that tax money is being used to subsidize the pirating of engineers for government defense contracts. Rep. Davis said that, "While commercial business firms had a greater volume of business than the firms with defense contracts, the latter group spent over ten times as much for recruiting. The average cost per engineer recruited is also higher, indicating that the availability of tax money is giving an unfair advantage to a special group." Rep. Davis is chairman of the Subcommittee on Manpower Utilization and Departmental Personnel Management.

Rep. Davis also said that salaries allowed as costs have also led to the demand for increasing the Federal pay scale for engineers at a rate faster than would normally be the case.

The Asst. Sec. of the Navy's report also shows that thirty-seven predominantly government defense contractors spent $2.4 million for Help-Wanted advertising, $1.1 million for recruiting expenses; $778,000 for travel expenses of new applicants; $347,000 for educational benefits; $1.3-million for moving expenses of new employees and $410,000 for other recruiting costs —making a total of $6,397,495 for engineering personnel procurement. The seventeen selected contractors with primarily commercial business ran up a total of $613,956 for the same items listed above.

Rep. Davis said that his Subcommittee requested the Secretary of Defense to: (1) urge firms with defense contracts to improve the utilization of their scientists and engineers; (2) set specific standards to govern the allowances for salaries and recruiting costs, including advertising; and (3) to make better use of the engineers and scientists in military uniform.

FOREIGN NEWS . . .

GLOW DISCHARGE ionitriding installation for workpieces up to 9½ ft long. A research institute for glow discharge is already underway in Cologne, and will be headed by the director of the Physical Institute of Bonn University.

High Current Glow Discharges For Industrial Use

Controlled high-current glow discharges, a new engineering aid, now provides the means to split gases into their atomic constituents, and offers a new procedure to converting electrical energy into thermal energy with a high degree of thermal efficiency, practically up to any temperature. As such, it provides the basis for a new metal-hardening process which Bernhard Berghaus, a German industrialist who developed the process, calls "ionitriding." Life expectancy of ionitrided parts, he says, is two to three times that of parts conventionally hardened. Application in other fields are being studied.

Berghaus' new method of converting electrical into thermal energy is based on the principle that: electrical energy accelerates many gas ions which hit the surface to be treated. The ion currents heat the material and result in a high thermal efficiency.

The new metal-hardening process is based on the nitriding process invented several years ago by Prof. Adolf Fry, of the Fried. Krupp AG. Berghaus says that his step goes one step further and "ionitrides" the metal. In an atmosphere of hydrogen and nitrogen gas, a blue radiating glow discharge is produced on the material under treatment, for instance, steel pipes, which are suspended under electrical insulation in the discharge vessel. The glow discharge has such an intensity that the pipes are heated to about 930 F and hardened by diffusion of nitrogen into the steel surface.

Despite the great energy conversion taking place, each steel vessel receives about 35 kw. Precision pipes can be ground to final tolerances prior to ionitriding without any distortion or other changes of dimensions.

Six of such steel pipes can be treated simultaneously in a steel vessel. The hardening takes place almost fully automatically with a high electrical efficiency and low gas consumption. The insertion and removal of the pipes takes about an hour. Actual ionitriding takes 20-50 hr, with little attendance required.

The iontriding process is particularly suitable for parts with a long, narrow or complicated bore or with interior profiles that call for uniform hardening; also for parts subject to high stress and temperatures and hard wear, as well as for parts with very small tolerances. The depth of hardness can be adapted to operating conditions and to the shape of the parts. There is no chipping or splitting at the nitrided layer or at the edge.

Berghaus says that ionitrided parts have the characteristics usually found with the conventional nitriding process: high surface hardness; high resistance to wear, high temperature, fatigue, corrosion; and good polishing properties.

Berghaus has carried out practical work in the field of ionitriding for the Swiss authorities. German rights have been secured by the firm Rheinmetall Berlin AG. Further possibilities of industrial application of the high-current glow discharge will be investigated by the research association Gesellschaft zur Foerderung der Glimmentladungsforschung e. V., Duesseldorf, sponsored by the government of Rhineland-Westphalia. A research institute for glow discharge already under construction in Cologne, to be headed by Prof. Walter Weizel, director of the Physical Institute of Bonn University, is also being financed by Rhineland-Westphalia.

Foreign News Briefs...

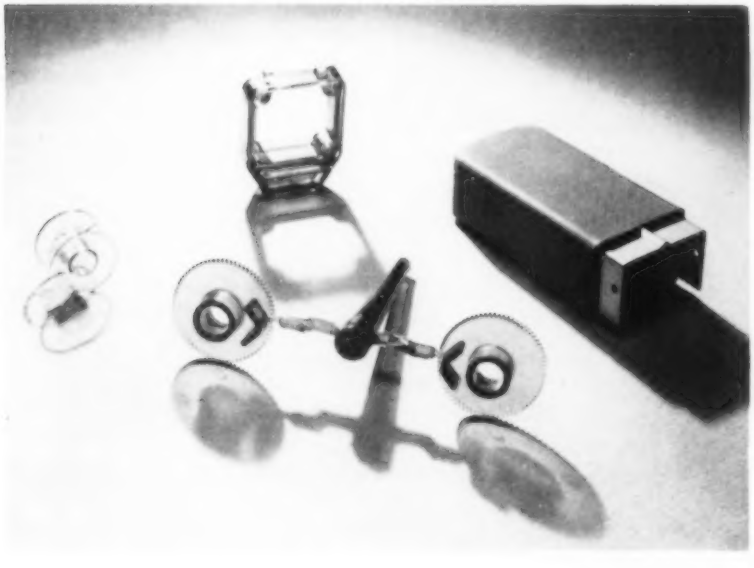
An experimental high speed submarine designed for the British Navy has as its main propulsion machinery turbines supplied with steam and carbon dioxide produced by burning diesel oil in an atmosphere of steam and oxygen formed by the decomposition of high test peroxide. As a result the sub is able to develop full power when completely submerged and independent of atmospheric oxygen. Conventional means of propulsion at lower speeds is by diesel for surface cruising, and on batteries when submerged.

Meter readings transmitted by spoken words previously recorded on a magnetic disk are being used to periodically transmit meter readings from fully automatic, unmanned, remote-controlled power stations and sub-stations to a central station. The instrument is

given a telephone subscriber's number and can be called from any telephone set. The call sets the speaking instrument in operation at which time the readings of the meters connected to it are phonetically transmitted to the caller in a predetermined order. The device consists of: (1) a play-back unit of a magnetic disk having 12 channels of varying radii, with each channel containing the words "zero" to "nine," "meter," and "reading," and 12 playback heads; (2) an audio-frequency amplifier for amplifying the recorded signals; (3) a register which stores the readings of the meters on a series of number rolls; (4) a control unit which programs the operation of the instrument; and (5) a power supply unit. The model will give one complete meter reading of 5 figures in 10 seconds. Designer of the instrument is Landis & Gyr, Zug, Switzerland.

Bronze requirements in the manufacture of bronze bearings are cut by 50% by mixing borax with bronze. This Russian process consists of heating borax and bronze pieces in a small drum, revolving it evenly to spread the molten borax-bronze alloy. One bronze liner is made in one minute. A high-frequency heating unit is wrapped around the revolving drum to produce a 2100 F temperature. The drum bottom and lid are fitted over a cylindrical steel sleeve which is to be the outer part of the bi-metal bearing. A predetermined amount of borax and bronze is inserted, and after starting the heating elements, the drum starts rotating. Borax and bronze melts in 60 sec with the rotation of the drum spreading the mixture evenly on the inside wall of the steel sleeve. The bottom and the lid are separated from the sleeve and cleaned for reuse. Minimum bearing diameter is 1.18 inch.

France has just started construction on its first nuclear powered submarine. The vessel will have a displacement of 5000 tons, and will be launched in about four years.



Plastic Has Metal's Toughness

From General Electric's research program for improved insulating materials has come the chemistry on which is based a new plastic material considered tough enough to replace metals in many applications. Lexan, the new polycarbonate resin, has an unusual combination of toughness, impact strength, heat resistance, and dimensional stability, which offer promise for applications not previously handled by conventional thermoplastics.

The resin is presently being made in small lots only, and is being avaluated in the company's testing program in the form of molding compound, extrusion compound, film, varnish, and coatings. Until these tests have been completed, samples will not be available for general distribution.

These facts are known:

Data shows little change in properties due to irradiation. The material can withstand much higher dosages than polyethylene before it breaks down.

After 200 hr in boiling water the properties remained the same.

A 9 week "dishwater" test showed good resistance to soap and detergent.

It can be dyed, pigmented, painted and reinforced with fibers.

As lexan is approaching metal in strength and toughness, combination plastic-metal assemblies may be replaced with integral assemblies.

Sprues and runners can be ground up and reused.

Its main weakness is chlorinated solvents.

Cost: Lexan is only in the pilot plant production stage, but initial price will be about $2.50 per lb. This is about $0.10 cu in., compared to Kel-F and Fluorothene which are over $0.32 cu in., and Plaskon Nylon and Zytel which cost from $0.03 to $0.09 cu in.

Properties: (at room temp on injection molded samples)

Impact Strength, unnotched Izod: > 50 ft-lb/in.

Tensile Impact: 600-900 ft-lb/cu in.

Tensile Yield Strength: 8000-9000 psi

Ultimate Tensile: 900-10,500 psi

Elongation: 60-100%

Flexural Strength: 11,000-13,000 psi

Water Absorption, 24 hr, immersion: 0.3%

Rockwell Hardness: M70

Dielectric Strength: 400 volts/mil

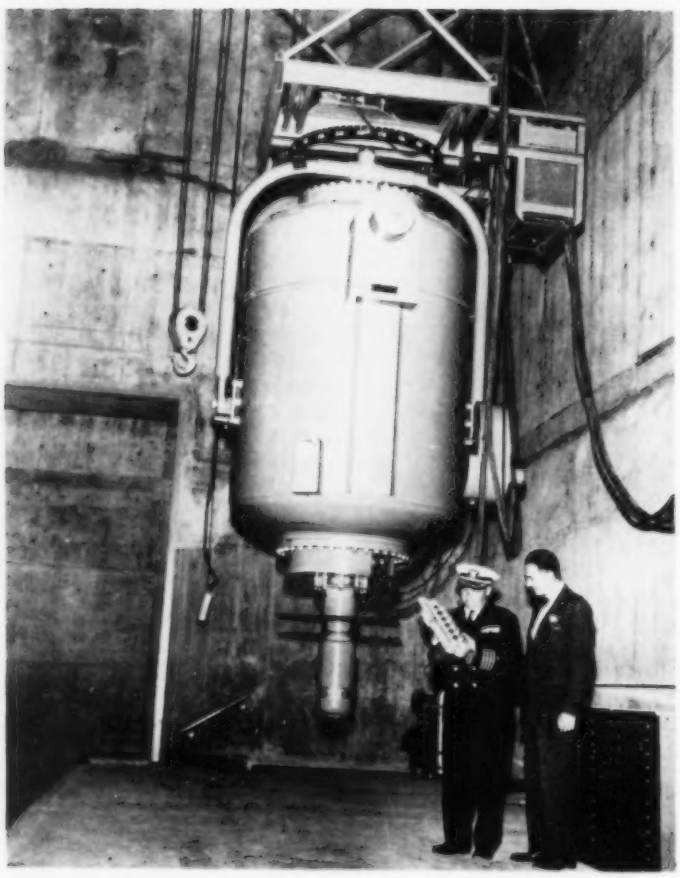
Dielectric Constant, 60 cycles: 2.80

Melting Point: 514 F

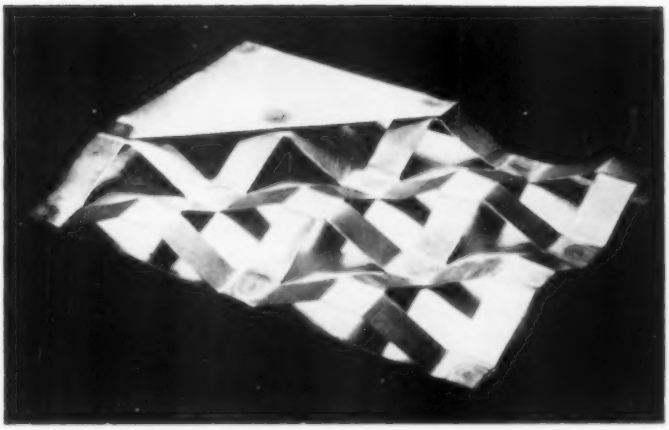
Heat Distortion Temperature, 264 psi: 280-290 F.

THE NEWS IN PICTURES

◀ FORD MOTOR CO. OFFERS an experimental addition to the farm machinery field with Typhoon, a tractor with a free piston engine power plant. Still undergoing tests at Ford's Birmingham, Michigan Div., the Typhoon is shown here pulling a tow dynamometer. Tests indicated a high starting torque and instant throttle response. The farm implements, operated by the power take-off shaft, are controlled independently of the tractor's forward motion. The engine has a potential of 100 hp, but is using one-half of this at present. Several advantages already indicated are: good fuel economy (the engine will run on a variety of hydrocarbon fuels); and greatly reduced engine friction and vibration. Still in the experimental stage with no actual production planned, the engine has the advantage of being without a crankshaft, camshaft connecting rods, spark plugs. Heart of the engine is the gasifier about the size of a farm milk can. The cylinder has two horizontally opposed pistons which move toward each other to compress the air for the firing stage. The heated gases drive the pistons part, and the gas exhausts through a 6 in. dia turbine wheel, which drives through a gear reduction system. Power is transmitted through a 10-speed forward, 2-speed reverse powershaft transmission.

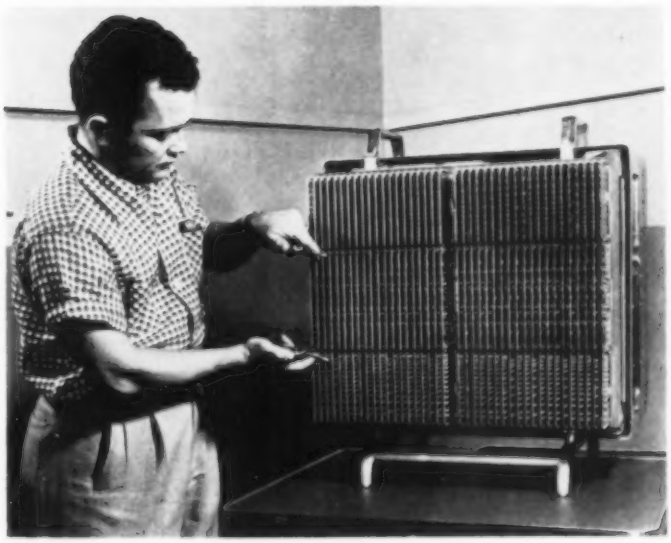


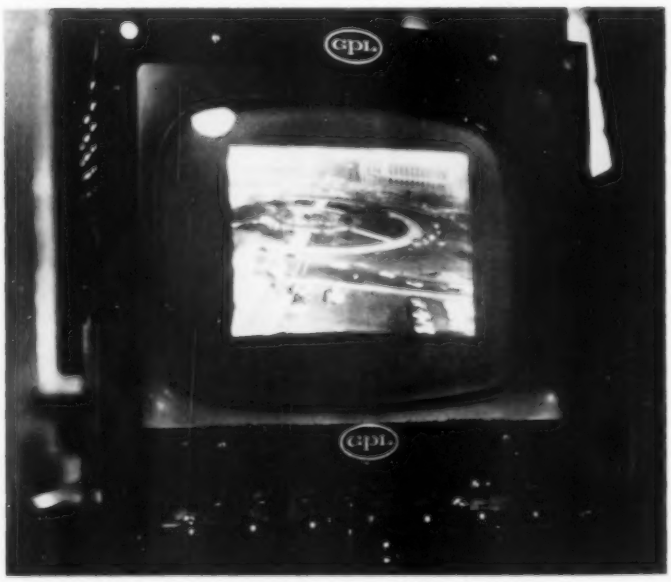
◀ WITH THIS 2,000,000 volt X-ray installation, the Navy will step up its nondestructive testing program of defense materials and structures and advanced weapons. Located at the U. S. Naval Magazine, Port Chicago, Concord, Calif., the facility is the first of its kind on the West Coast. Services of the X-ray plant will be made available to commercial firms holding government contracts, as well as to other agencies of the Department of Defense. The X-ray unit, made by General Electric, is housed in a concrete building large enough to accommodate a railroad car or large truck carrying items of great size. The building also houses a 250,000 v machine. The Port Chicago Naval installation has been charged with coordinating and establishing uniform evaluation criteria of all nondestructive testing efforts related to surveillance and Naval Ordnance.



◀ SOMETHING NEW IN steel sandwich structures is this German sandwich plate made from three thin steel sheets. The middle sheet is punched according to a specified pattern and spot welded at alternate points (see cutaway section above) on the upper and lower cover sheets. The outside edges are welded together except at one point where water is pumped at high pressure into the 3-plate structure. The water pressure forces the two coverplates further apart, distending the middle plate, and, according to reports, produces a sandwich plate of good rigidity. The designer, J. H. Melzer, 36 Volgerstrasse, Weinheim/Bergstrasse, Germany, is looking for a manufacturer to produce it.

▶ PORTABILITY and large-computer performance are the features of the Recomp (reliable computer), a general purpose, all transistor computer, developed for the Air Force by the Autonetics Div. of North American Aviation, Inc., Downey, Calif. Weighing 210 lb and occupying 6 cu ft, the Recomp is a serial, single-address, internally binary computer having from 12 to 16 arithmetic instructions, 17 logical and transfer instructions and from 5 to 8 input-output instructions. It was designed to use a rotary magnetic disk memory with a main memory capacity of 4032 words on 4 arithmetic registers. Each word consists of 40 bits, including sign and 2 instructions. Information can be fed into the computer by decimal entry of mixed numbers, using an electric typewriter, paper tape reader, or control panel keyboard. Output may be decimal, octal, or binary. Circuitry has been standardized to 4 basic types of small, plug-in printed circuit cards mounted on hinged panels for easy access. Power supply is 115 v, 50-60 cps, with a dissipation of 600 watts.





◀ AFTER TRANSMISSION over ordinary telephone cable facilities, the narrow band television picture of Philadelphia traffic is shown on a monitor screen. Narrow band television uses a bandwidth of 250,000 cycles, compared with the 4,000,000 cycle bandwidth required for transmission over video cable. Using standard telephone cable facilities for transmission, the system operates successfully up to distances of 10-15 miles. While the lowered frequency results in pictures of less resolution than in regular broadcast transmission, they are of sufficient quality to be used for a variety of industrial applications where picture quality is not the prime consideration. In one version, pictures are sent at 1/15 sec rather than 1/30 sec, and over-all definition is changed from a nominal 525 line picture to about 185 lines. When using the telephone cables for transmission, it is necessary to use special equipment for correction of phase and attenuation distortion and in some cases special intermediate amplifiers. General Precision Lab., Inc., and Dage Television Div., of Thompson Products, Inc., designed the equipment for the Bell Telephone Co. of Pennsylvania.

TECHNICAL NEWS

NEWS BRIEFS

Depending on the curing processes used in fabrication, G.E.'s new 81716 silicone rubber compound (still in the evaluation stage) will have physical property values of about 1500-1800 psi tensile strength; 600 to 750% elongation; and 180 to 225 psi tear strength. These properties were gained after short oven cures of one hour at 300 F. Developed at the Waterford, N. Y. plant, this high strength compound is said to be the only one now available to meet AMS 3345 requirements for tensile and tear strength, elongation, dry heat resistance, compression set, and low temperature flexibility. Figures compare the tensile strength and elongation with those of typical synthetic organic and silicone rubbers used for air frame seals. To date the compound has been found to have good handling characteristics for extrusion, calendering and molding.

Privately employed nuclear scientists and engineers can get specialized work experience in Atomic Energy Commission laboratories and plants, according to the announcement of the AEC's enlarged program. The move is another aid in the further development and use of atomic energy for peaceful purposes. Administered by the Commission's field offices, its primary purpose is to help people already generally educated and trained in nuclear science and technology to become further familiar with specific uses. However, it is not intended as a program offering basic training. While such an arrangement is not entirely new with the AEC, the work experience program is now on a systematized basis. Inquiries should be made to the Commission's field operations office having jurisdiction over the facility in which work experience is desired. Or, to The Director, Div. of Civilian Application, Atomic Energy Commission, Wash., D. C.

Martin Co., Baltimore, Md., at a recent meeting, discussed the results of a study made on the feasibility of recovering the scientific payload of rocket research vehicles which have spent much time out of the atmosphere. The objective is to stimulate activity in this field. The preliminary design study of such a vehicle could be exposed for a considerable period of time to the primary cosmic radiation. The design study showed that a payload of 150 lb can be projected more than 2000 miles into space, using rocket components which are available today. Of this 150 lb, one-third will be useful from the scientific standpoint; the other two-thirds will be structure and protection required for recovery. The payload will spend 40 min above the atmosphere, and upon re-entering the earth's atmosphere will attain a speed of 13,000 mph.

Lockheed Aircraft's Missile Div. in Van Nuys, Calif., is operating its computer department on a do-it-yourself basis. All employees, after they take a 12 hr course in programming will be able to use the company's IBM-650 whenever a problem comes up. The plan is expected to ease the work load of the professional programmers.

Shuttles on looms can now be driven by a fluid propellant such as a liquid or gas. A small gasoline cylinder is located at each side of the loom, and the shuttle furnishes the compression cycle and actuates the spark for exploding the gas. The use of such a power driven shuttle is expected to eliminate about 35 moving parts on present looms, reduce vibration, and greatly increase the speed of the loom. It also will be possible to weave fabrics wider than those which can be woven with shuttles driven by conventional picker sticks. The new shuttle can be incorporated in new or existing looms, according to The American Viscose Corp., Philadelphia 3, Pa., who is offering licenses on it.

RAIL WHEELS FALL DOWN INTO PLACE to make this trailer truck a rail rolling freight car. Called the Railvan, the vehicle was developed by the Chesapeake and Ohio Railway to take advantage of the low cost of rail haul and the flexibility of the truck for terminal distribution. Key to the suspension system is the Torsilastic spring made by B. F. Goodrich Co., Akron, Ohio. The arms supporting both highway and rail wheels are attached to the outer casing of the spring. This is made up of a rubber tube bonded to an inner stationary metal tube and a movable outer metal sleeve. Deflection of the rubber gives the necessary elasticity. The suspension permits easy control of the length of the highway and rail arms, so that the spring deflection for both highway and rail operation is the same. The stationary elements of the spring are linked through a splined sleeve and an arm to the actuator screw, which is driven through a gear train by a motor. Working from a 90 psi air brake pipe pressure, the air motor twists the spring, transferring the railvan wheels from the highway to the rail position or vice versa in about 30 seconds. The same level can be obtained regardless of the load weight.

COMING EVENTS

MAY 8-11

Fluid Control Institute Meeting, The Greenbriar, White Sulphur Springs, West Virginia.

MAY 9-10

Annual Meeting of the IRE Professional Group on Microwave Theory and Technique, Western Union Auditorium, New York City.

MAY 9-10

Pacific Northwest Instrumentation and Automation Exhibit, Seattle, Wash. The exhibit will be sponsored by the Seattle Section of the ISA.

MAY 14-16

Second Annual Industrial Nuclear Technology Conference, Museum of Science and Industry, Chicago, Ill. The event will be sponsored by the Armour Research Foundation of the Illinois Institute of Technology, and Nucleonics magazine.

MAY 15-16

Southern Research Institute, Birmingham, Ala. Symposium to discuss current developments in the rocket and missile field.

MAY 20-22

Northeast Region Spring Conference, Syracuse University, and the Hotel Syracuse, in Syracuse, N. Y. The conference will be on Corrosion Control by Choice of Materials. Sponsors are the Central New York section of the National Association of Corrosion Engineers, and Syracuse University.

MAY 20-23

Second Design Engineering Show and Conference, the Coliseum, New York City. At least 375 exhibitors are scheduled to have booths for the display of products, components and materials of particular interest to the designer. The annual Design Conference is sponsored by the Machine Design Division of the ASME. For further information on the conference schedule, including photographs of the speakers, and abstracts of their papers, see page 185 of this issue.

JUNE 2-5

41st Annual Meeting of the American Gear Manufacturers Association, The Homestead Hotel, Hot Springs, Va.

JUNE 6-7

First National Symposium on Production Technique, Hotel Willard, Washington, D.C. There will be a panel discussion on "How to Prepare For and Implement Automation," which will be an over-all look at the problems that faced the present users in implementing an automation program. Another panel discussion will be on "Military Problems in Electronic Automation." The military problems will be discussed by representatives of the military and governmental agencies. Another session will be devoted to "Designs for Production," and papers are invited from engineers concerning their experiences with new materials, designs, testing, etc.

JUNE 9-13

ASME Semi-Annual Meeting, Sheraton-Palace, San Francisco, Calif. There will be papers on: "The Mechanical Design Approach to Simplified Maintenance," "The Titanium Sheet Rolling Program," "Metals Engineering and Fabrication Aspects of High Speed Aircraft," "New Materials and Processes for the 'Hot' Airplane," "Automation and New Methods for Overhaul," etc.

JUNE 9-13

Fourth International Automation Exposition, The Coliseum, New York City. To be held with the Military Automation Exposition.

JUNE 9-14

Third Annual Automation Seminar, Pennsylvania State University, University Park, Pa. Seminar expanded this year to include automation for in-line manufacturing methods of getting parts into and out of machinery, control systems and utilization of standard components.

JUNE 11-14

Fourth Annual Industrial Engineering Seminars, Cornell University, Ithaca, N. Y. There will be ten seminar workshop sessions in each of six major areas of industrial engineering: (1) Industrial Management; (2) Manufacturing Engineering; (3) Small Plant Management; (4) Methods and Work Measurement; (5) Applied Industrial Statistics; and (6) Data Processing Systems. In addition, during the four day period, seven industrial and educational leaders will speak at sessions attended by all participants.

JUNE 14

Regional Technical Conference, Lowell Institute of Technology, Lowell, Mass. The conference will be on "Plastics for Electronics."

JUNE 16-21

Fourth Annual Seminar in Creative Engineering, Pennsylvania State University, University Park, Pa.

JUNE 19-21

Twelfth Annual Meeting of the Association for Computing Machinery, University of Houston, Houston, Texas.

AUGUST 11-15

First National Conference on Applied Heat Transfer, Pennsylvania State University, University Park, Pa. Sponsored by the Heat Transfer Div. and the Central Pennsylvania Section of ASME. The theme will be Applied Heat Transfer, and papers are being solicited which bear directly upon heat transfer applications. Particularly sought are papers dealing with the design, construction, and use of heat exchangers, economic and practical problems associated with insulation, methods of instrumentation and tests, and the results of research which may be applied in industrial practice.

SEPTEMBER 9-13

12th Annual Instrument and Automation Conference and Exhibit, Cleveland Auditorium, Cleveland, Ohio.

SEPTEMBER 9-13

Third Annual Titanium Lecture Program of New York University's College of Engineering, University Heights, New York 53, N. Y. Attendance at the program is limited. American and foreign authorities from industry and research laboratories will present the lectures.

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

Can We Afford a $71.8 Billion Budget?

THE BUDGET submitted to Congress by President Eisenhower for the year beginning July 1 proposes federal spending of $71.8 billion. In only four years, three during World War II and one during the Korean War, has the government spent more. Under the proposed budget the government expects to collect $73.6 billion, mostly through individual and corporation income taxes.†

The principal reason for the size of the budget and for this year's increase is an expanding defense program. About 60% of all budget expenditures in the coming fiscal year will be for national security programs. Moreover, this area accounts for about 90% of the proposed increase in federal spending. In addition, as the chart shows, there are large expenditures proposed for purposes other than defense.

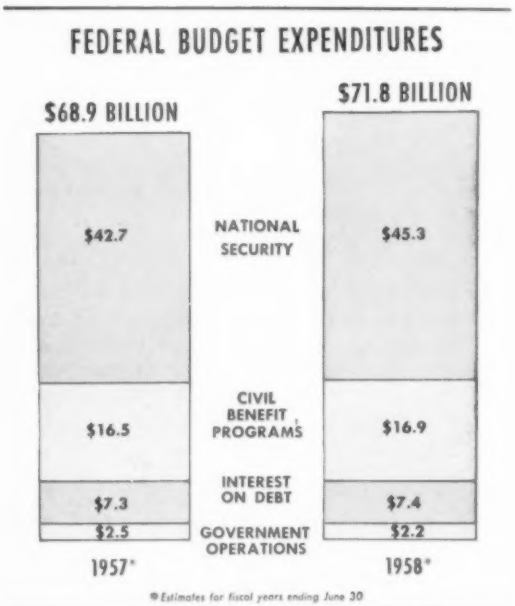
Continued budgets of this size, some contend, will lead to inflation and wreck our economy. It has been suggested that they might lead to "a depression that will curl your hair." Yet many insist that the budget, large as it is, still is inadequate in many respects — for defense, schools, agriculture, small business, health, research, indeed, for almost every activity in which the government has become involved.

Is It Really Too Big?

Actually, the proposed budget would place no greater burden on the economy than any budget in the last six years, because our economy has been growing. Federal spending per capita under the proposed budget will be about $416, or $10 more than this year; but our per capita income rose almost $80 last year. And, because of our increasing population, next year's expenditures will, in fact, amount to *less* per capita than in 1954 when federal spending was $4 billion lower.

Another way of measuring the burden of government expenditures on the economy is to compare the purchases of goods and services of all branches of government — federal, state and local — with the total output of the nation. The share of our national product taken by government this year will be about the same as in the past two years and, furthermore, about the same as the average for the past 28 years.

By the standard of any recent year, the budget is within the means of the American economy. In this sense, we can "afford" it. But the pros-



†*These figures refer to the regular federal budget and do not include operations of trust funds, primarily for social security programs and the new federal aid program for highways, which are financed by special taxes.*

pect of steadily increasing budgets, requiring 20% or more of our national income, introduces another threat.

The Real Threat

Large and rising budgets that do not balance government spending with higher tax collections clearly would be inflationary and would destroy the value of the savings and income of all who lagged in the race with climbing prices. But serious dangers will still exist even if our budget continues to be balanced, as this year's is.

- **Budgets that require a large take in taxes eat up the savings required to finance private industry.** What the taxpayers must give the government they cannot save. This deprives private industry of the savings and resources needed to expand and modernize producing facilities.
- **High tax rates also undermine the incentive to save and invest in normal business enterprises by taking such a large share of any income gained.** Taxes on corporation income now take 52% of all income over $25,000. And taxes on individual incomes can take as much as 90% of earnings that remain after this 52% bite.
- **High taxes encourage, on the part of both individuals and corporations, the search for "gimmicks" and special treatment.** As a leading character in Cameron Hawley's novel *Executive Suite* observed: "To a far greater degree than most people realize, income tax has become a primary governing factor in corporation management." Indeed, it is only because of the numerous gimmicks and special provisions now available that high tax rates have not already inflicted greater damage to economic incentives.

These dangers comprise the real threat of large and rising federal budgets. It is a threat to continued growth of our economy, and it is no less a threat merely because the budget is technically in balance.

What Should Be Done?

In attempting to hold government spending within reasonable bounds, we should *not* hold back on needed civilian programs. The heavy demands now being urged at all levels of government for roads and schools, for instance, are largely the result of failure to keep pace with the growth of the country. Furthermore, we cannot cut provisions for national security below the minimum level of safety. And unhappily, defense in the rocket and missile age is fantastically and ever increasingly expensive.

What we *can* do is enforce some financial discipline on our military leaders, and hold down our defense expenditures by making sure their demands are justified and by requiring efficiency. In the civilian programs, though some need to be increased to serve a growing economy, we can eliminate the outright waste.

A More Difficult Job

We must also do something far more difficult, and that is to reduce federal programs of aid to special groups at the expense of all the taxpayers. The new budget calls for over $5 billion for veterans, and another $5 billion for farmers. A number of industries and areas stand to receive aid in large amounts based less on necessity than on political pressure. These demands for increased aid, year after year, must be resisted if we are to have any hope of stopping a relentless rise in our budget.

Then, as our national income increases, we can look forward to reducing tax rates and providing greater incentives for the private sector of the economy. **Only in this way — by keeping government spending in line with economic growth — can we prevent our federal budget from being a crippling burden.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Contact points able to survive this brutal shear test stay on forever

STANDARDS THAT DETERMINE RELAY QUALITY/

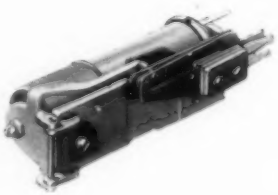
contact points that stay on for keeps

Superior attachment technique guards against insecure welds.

When you find a relay that sheds its contacts, you usually have a relay that's suffering from "cold welds"; this means that when the contact spring was made, the contact and the spring did not really weld together. When that happens, the contact is likely to fall off at any time.

We prevent that, here at Automatic Electric, by making contacts from a continuous length of precious-metal wire. In one combined operation, we weld the end of this wire to the spring blank (using very accurate control of time and voltage), pinch it off so as to provide exactly the right amount of material for the contact, and finally form it into a dome of the contact metal. Result: a contact with a polished surface, welded to the spring for the life of the relay. This is one more reason why Automatic Electric relays set performance records of 200 to 400 million operations without a failure!

This superior method is typical of the painstaking care that goes into *every* relay we make.



Class "A" Relay—for use when low first cost is important. *Write today for Circular 1702. Automatic Electric Sales Corporation, Chicago 7.* **In Canada:** *Automatic Electric Sales (Canada) Ltd., Toronto.* Offices in principal cities.

AUTOMATIC ELECTRIC

A MEMBER OF THE GENERAL TELEPHONE SYSTEM

ONE OF AMERICA'S GREAT COMMUNICATIONS SYSTEMS

Machining Tolerances

Variations from basic dimensions for different machining operations based on automotive engineering standards. Tolerances may be applied generally to designs for quantity production, with changes as needed to suit individual requirements.

Based on engineering standards used by a leading automotive manufacturer.

Drilled Holes

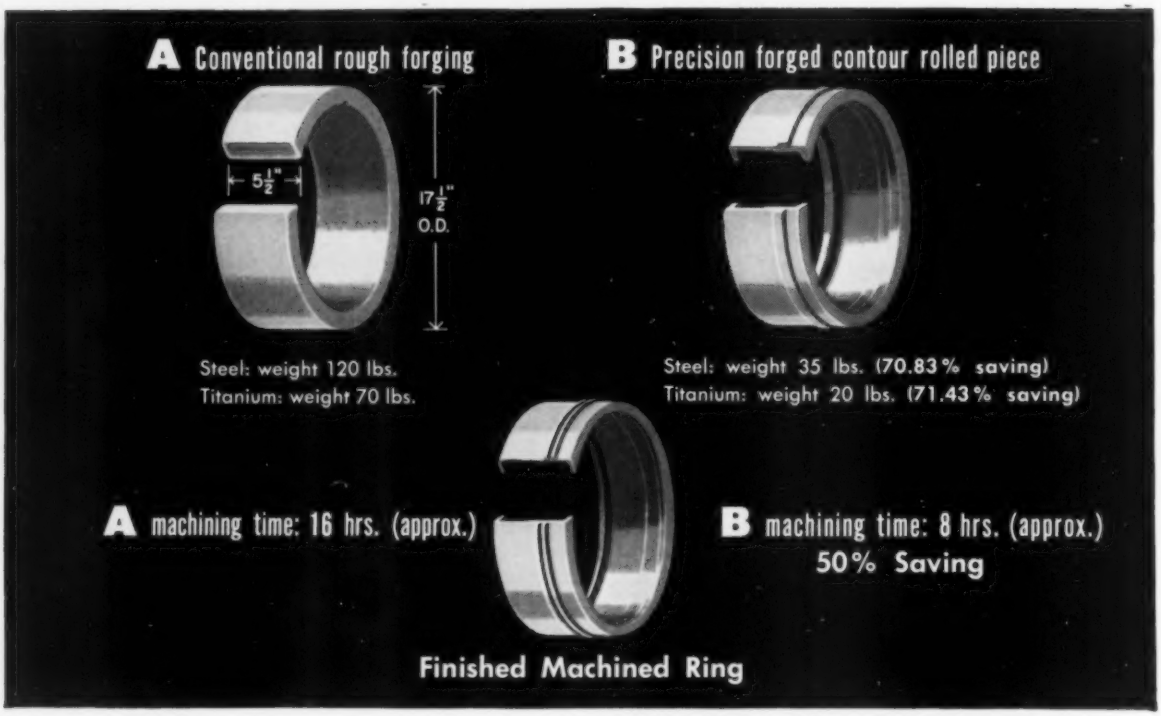
Drill size, in.	Tolerance, in.	Drill size, in.	Tolerance, in.
0.0135 to 0.0420	+0.003 −0.002	0.2660 to 0.4219	+0.007 −0.002
0.0430 to 0.0930	+0.004 −0.002	0.4375 to 0.6094	+0.008 −0.002
0.0935 to 0.1560	+0.005 −0.002	0.6250 to 0.8437	+0.009 −0.003
0.1562 to 0.2656	+0.006 −0.002	0.8594 to 2.0000	+0.010 −0.003

Diameter or stock size, in.		to 0.250	0.251 to 0.500	0.501 to 0.750	0.751 to 1.000	1.001 to 2.000	2.001 to 4.000
Reaming	Hand	±0.0005	±0.0005	±0.0010	±0.0010	±0.0020	±0.0030
	Machine	±0.0010	±0.0010	±0.0010 −0.0015	±0.0010 −0.0020	±0.0020	±0.0030
Turning			±0.0010	±0.0010	±0.0010	±0.0020	±0.0030
Boring			±0.0010	±0.0010	±0.0015	±0.0020	±0.0030
Automatic screw machine	Internal External forming External shaving Shoulder location (Turning) Shoulder location (Forming)	Same as in Drilling, Reaming or Boring ±0.0015 ±0.0010 ±0.0050 ±0.0015	±0.0020 ±0.0010 ±0.0050 ±0.0015	±0.0020 ±0.0010 ±0.0050 ±0.0015	±0.0025 ±0.0010 ±0.0050 ±0.0015	±0.0025 ±0.0015 ±0.0050 ±0.0015	±0.0030 ±0.0020 ±0.0050 ±0.0015
Milling (Single cut)	Straddle Slotting (width) Face End (Slot widths) Hollow	±0.0020 ±0.0015 ±0.0020 ±0.0020	±0.0020 ±0.0015 ±0.0020 ±0.0025 ±0.0060	±0.0020 ±0.0020 ±0.0020 ±0.0025 ±0.0080	±0.0020 ±0.0020 ±0.0020 ±0.0025 ±0.0100	±0.0020 ±0.0020 ±0.0020	±0.0020 ±0.0025 ±0.0020
Broaching	Internal Surface (thickness)	±0.0005	±0.0005 ±0.0010	±0.0005 ±0.0010	±0.0005 ±0.0010	±0.0010 ±0.0015	±0.0015 ±0.0015
Precision boring	Diameter	+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0010 −0.0000
	Shoulder depth	+0.0010	+0.0010	+0.0010	+0.0010	+0.0010	+0.0010
Hobbing		±0.0005	±0.0010	±0.0010	±0.0010	±0.0015	±0.0020
Honing		+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0008 −0.0000	+0.0010 −0.0000
Shaping (gear)		±0.0005	±0.0010	±0.0010	±0.0010	±0.0015	±0.0020
Burnishing		±0.0005	±0.0005	±0.0005	±0.0005	±0.0008	±0.0010
Grinding	Cylindrical (external)	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005
	Cylindrical (internal)		+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000	+0.0005 −0.0000
	Centerless	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005	+0.0000 −0.0005
	Surface (thickness)	+0.0000 −0.0020	+0.0000 −0.0020	+0.0000 −0.0030	+0.0000 −0.0030	+0.0000 −0.0040	+0.0000 −0.0050

The difference in these processes could be

worth millions

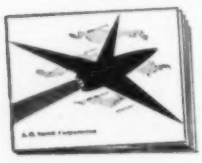
to your company


A Conventional rough forging
B Precision forged contour rolled piece
5½"
17½" O.D.
Steel: weight 120 lbs.
Titanium: weight 70 lbs.
Steel: weight 35 lbs. (70.83% saving)
Titanium: weight 20 lbs. (71.43% saving)
A machining time: 16 hrs. (approx.)
B machining time: 8 hrs. (approx.)
50% Saving
Finished Machined Ring

The difference is E.D.O.S.

Engineered Designs for Optimum Structures

FROM the example above it is evident that material costs *alone*, using conventional methods, can exceed the total finished cost of parts produced by the exclusive A. O. Smith E.D.O.S. process. By comparing a conventional rough forging with a precision-forged, contour-rolled ring (A and B illustrated above), material cost of the finished ring is cut by more than 70% — machining time cut by 50%! These great savings — due to conservation of costly metal by predetermined distribution — are possible with steel, titanium and other heat-resistant alloys. The whole E.D.O.S. process (involving precision forging, contour rolling, flash and fusion welding) can build a lighter, stronger product faster and at lower cost than any other existing method! For further information about E.D.O.S., contact A. O. Smith Corporation, Milwaukee 1, Wisconsin.



WRITE TODAY FOR FREE ILLUSTRATED BOOKLET — Bulletin I-17A — Complete with technical details. Also arrange for showing of new 16-mm. sound color movie about this remarkable process.

Through research ... *a better way*

A.O.Smith

CORPORATION

MILWAUKEE 1, WISCONSIN

International Division: MILWAUKEE 1, WISCONSIN

Resistance of Parallel Circuits

LEO FIDERER, *Design Engineer, Huck Company, New York, N. Y.*

Computation of total electrical resistance in parallel resistance circuits is a time-consuming operation which becomes more complex when four or more resistances are involved. This alignment chart gives a quick graphical solution accurate to two significant figures.

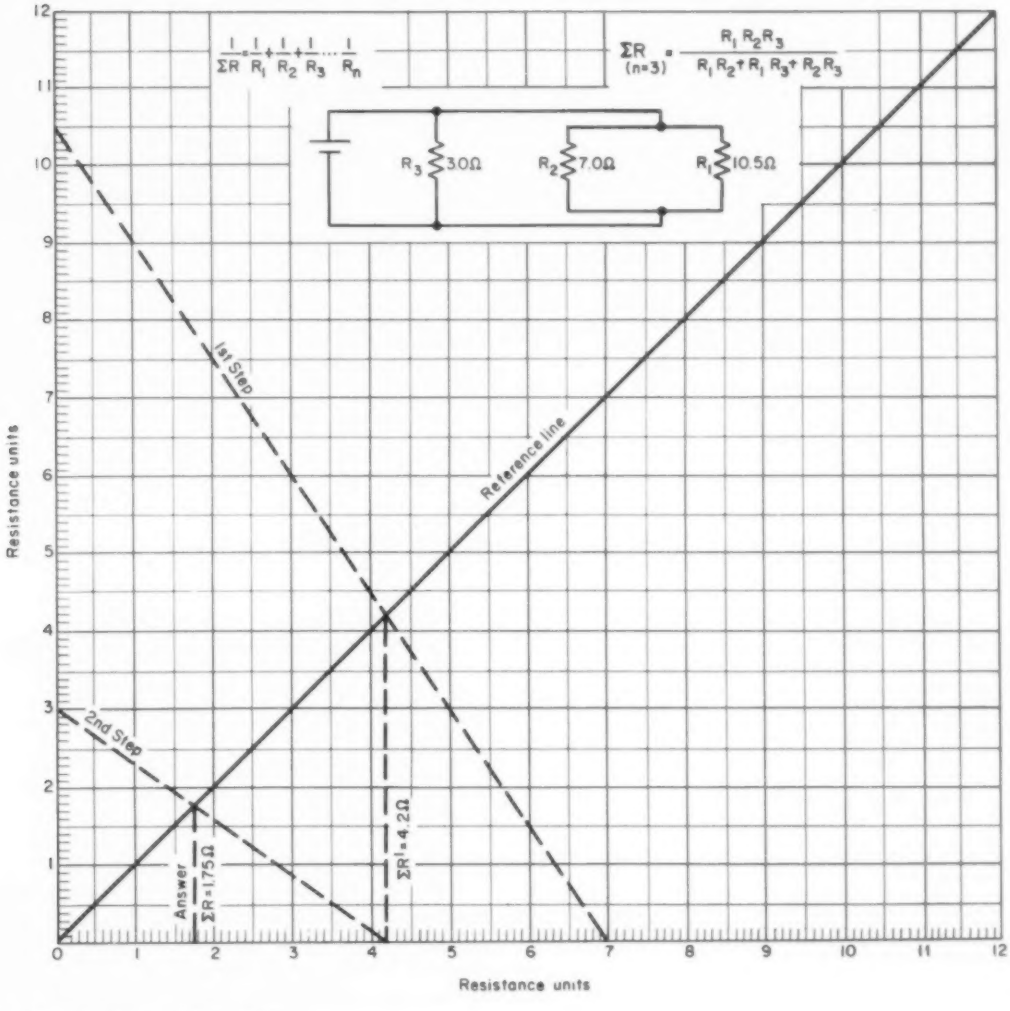
Joining any two resistances with a straight line intersecting the reference line finds the equivalent resistance for the two. This can be combined with a third and then a fourth and so on.

Example:

A three-branch parallel circuit has the resistances $R_1 = 10.5$ ohm, $R_2 = 7.0$ ohm, $R_3 = 3.0$ ohm. What is the total equivalent electrical resistance of this circuit?

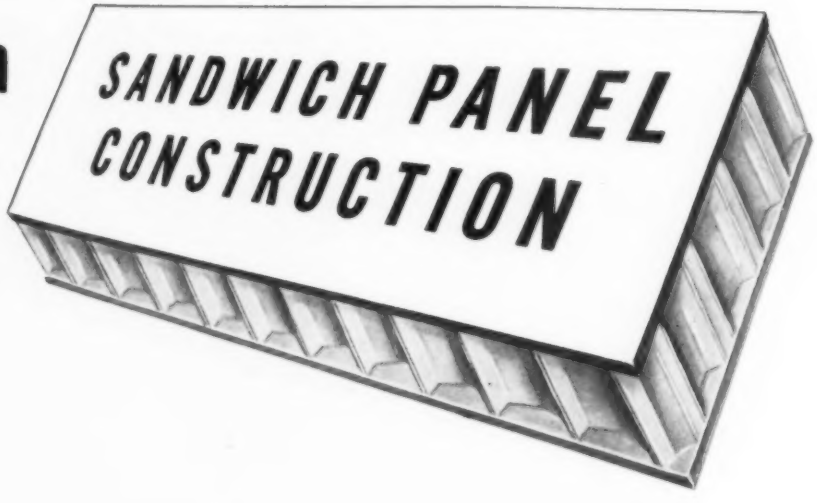
Solution:

Straight line from $R_1 = 10.5$ to $R_2 = 7.0$ intersects reference at $\Sigma R' = 4.2$ ohm, the equivalent resistance for the two branches. Line from 4.2 to $R_3 = 3.0$ intersects reference line at 1.75 ohm. This is the final answer.



Quality is more than "skin" deep

in SANDWICH PANEL CONSTRUCTION



Between the skin, or outer face, and the core is the adhesive. Here is where you find the key to the life of sandwich panel assembly.

What amount of dead load will the adhesive stand? How rigid or heat resistant is the assembly? Someone has to have the answers to these questions.

Angier has the experience and the testing equipment that can supply most of the answers for sandwich panel construction, including the bonding of sheet metal, plastic laminate and hardboard to cores of honeycomb or foam. We invite all questions you may have concerning your requirements or our experience.

Write for more specific data on our SW-570 series (elastomeric type) for Rigid Laminating and Sandwich Panel Construction as well as the vinyl phenolic and epoxy types for Sandwiches.

For EVERY Industry: Latest developments in adhesives for Mylar* Lamination, Vinyl Film Bonding, also Rubber, Latex and Resin Cements, Pressure Sensitive Cements, Flocking Cements, Laminants, Sealants, Tie Coats and Resin Emulsions.

*Mylar is DuPont's registered trademark for its brand of polyester film.

ANGIER ADHESIVES

Angier Adhesives

Division of Interchemical Corporation

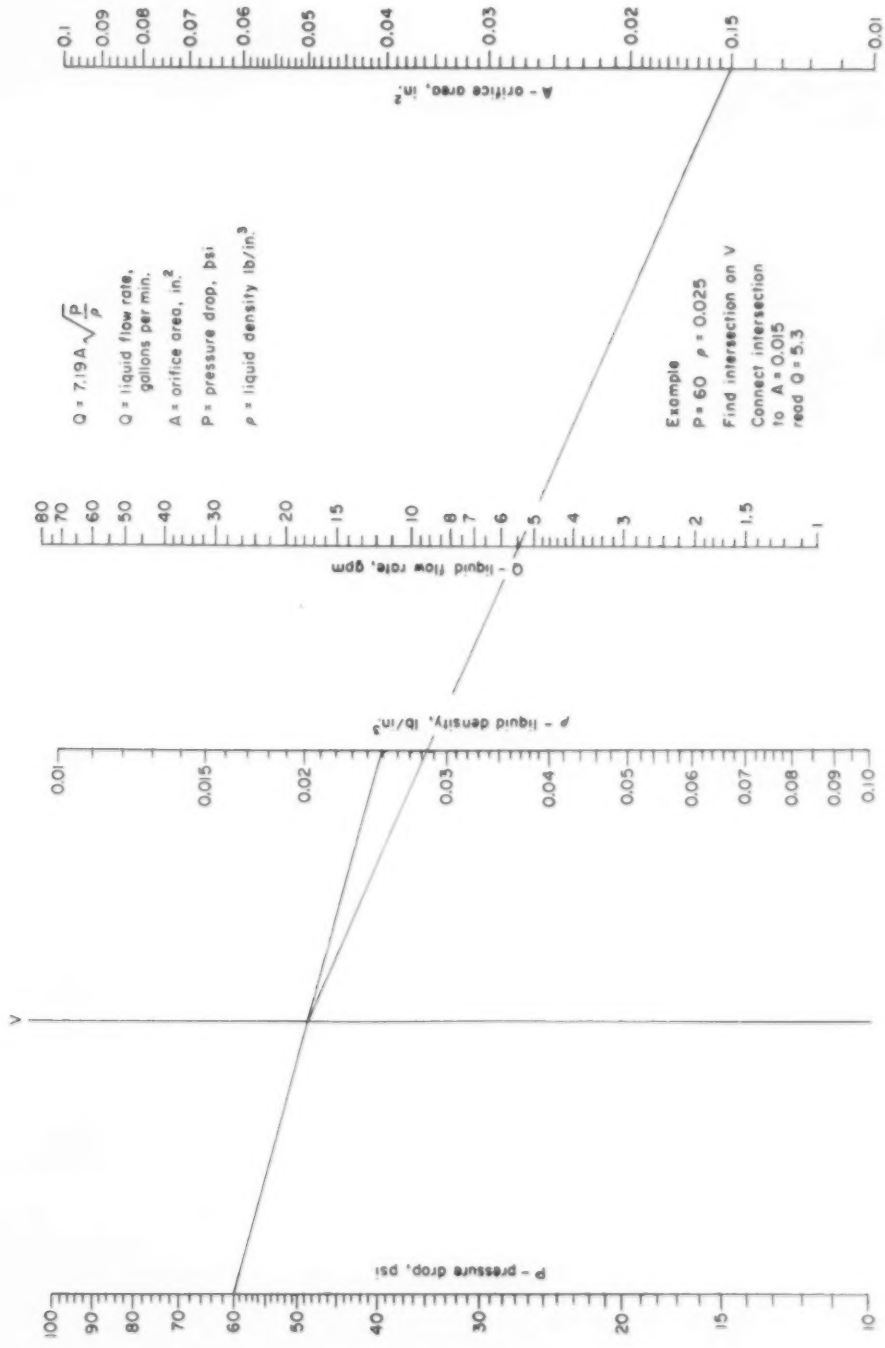
120 POTTER STREET, CAMBRIDGE 42, MASSACHUSETTS

Midwestern Plant
HUNTINGTON, INDIANA

© 1957 ANGIER ADHESIVES

Flow Rate of Liquids Through Orifices

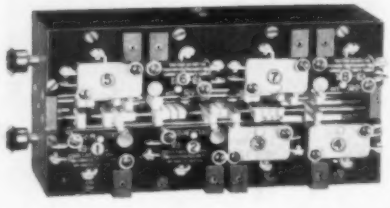
HOWELL C. LOWE *special projects group engineer, Electrol, Inc.*

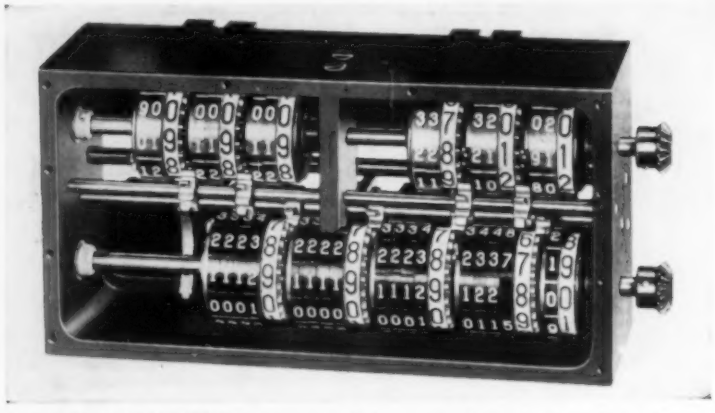


Nomogram relates pressure drop, liquid density and orifice area for theoretical flow rates from 1 to 80 gpm and pressures from 10 to 100 psi.

NEW COMPONENTS and . . . .

Mechanical components, electrical and fluid power and control systems, materials of construction, engineering department equipment to be introduced at the Design Engineering Show, at New York's Coliseum, May 20 to 23, and not previously described in Product Engineering.





MULTIPLE CAM RINGS actuate switches at predetermined settings of programming counter.

Switch	Yoke Action on Cam Rings
1	Second cam ring on last four wheels holds contact 10 counts
2	First cam ring on all five wheels holds contact 1 count
3	Fourth cam ring on last four wheels holds contact 10 counts
4	Third cam ring on last four wheels holds contact 10 counts
5	Second cam ring on all three wheels holds contact 1 count
6	First cam ring on all three wheels holds contact 1 count
7	Second cam ring on all three wheels holds contact 1 count
8	First cam ring on all three wheels holds contact 1 count

Programming Counter Controls Multiple Switches

This counting device was originally developed for missile control. In this and other control applications its function is to close from one to eight or more switches at predetermined settings, within a given range. The counter can be mechanically set to give consecutive contacts at such varied numbers as 4, 158, 210, 896, 975, 8756, 40,128.

The counter is designed for rotary drive. Maximum torque at input shaft is 5.5 in-oz for one switch actuation. Speed is 500 rpm at input shaft. The counter shown is 5⅞ x 3 x 2¼ in. deep. Weight is 35.5 oz. Frame is cast aluminum and shaft is stainless steel. Hardened steel running parts and stainless steel cam rings are used. Setting of the numbers is accomplished by rotating the cam rings to the number desired. This is done with a pick, or with the fingers if the counter is mounted.

The accompanying photograph and table above lists the control function of each of the illustrated counter's eight switches. All switches are normally open and the above table details function upon closing.

The programmer is built to conform to military specifications covering salt spray, humidity, heat and cold, and fungus, generally applicable to missile and aircraft instrumentation. Recent models have been designed to withstand high impact and vibration tests.

Counters of this type must necessarily be designed for a specific application, and are built to individual order. The complexity and precision design of the unit make it applicable only for programming control where rigid material and performance specifications are required, and where a quantity of units will be used. Four basic designs have been developed, all for use where a plurality of contacts are required at selected numbers. Durant Mfg. Co., 1938 N. Buffum St., Milwaukee 1, Wis.

For more information—

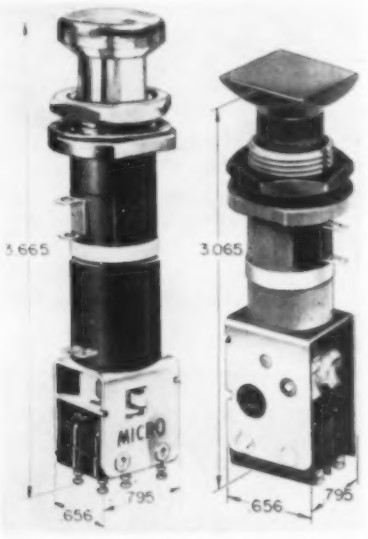
see Booth 1141, Design Engineering Show

Two Lighted Pushbuttons

An alternate-action switch is a maintained-contact switch which provides one-button on-off control. Each time the switch button is pushed, the contacts of the precision snap-action basic switches are alternately reversed, providing double-pole double-throw operation. Maintained contact and alternate action can eliminate holding relays and allow one button control of up to four circuits.

Another switch development, a magnetically held, electrically released, lighted pushbutton switch, is a momentary double-pole, double-throw unit when its built-in holding solenoid is not energized. When the solenoid is energized, the button stays in the operated position when pushed. It may then be released electrically from

MATERIALS at the Design Show



any remote point. This switch can also eliminate external holding relays in many applications. Micro Switch, Div. Minneapolis-Honeywell Co., Freepoort, Ill.

For more information—
see Booth 744, Design Engineering Show

Fan-Cooled Air Pump

This rotary-vane pump delivers 45 cfm. Designed for continuous, heavy-duty service as either compressor or vacuum pump, the unit is air-cooled by a 10 in. dia pitch fan externally mounted on a rear-end shaft extension. Air is directed by a combination cowl and fan guard.

As a compressor, with V-belt drive at 1750 rpm, the unit delivers 20 psi continuously with 5 hp motor. For lower pressures and for vacuum to 25 in. Hg, a 3 hp motor is recommended. Where displacements of 35 cfm or less are adequate, the pump may be operated at 1350 rpm, with 2 or 3 hp motor. Drive with two A-section V-belts is recommended.

Five composition vanes are used. Vanes slide in slots milled and ground in the cast iron rotor. Rotor is mounted on a steel shaft brazed as one unit, locked in position at drive end with double-row ball bearings. Single-row bearings at rear end are removable for inspection or servicing. Body and end-plates are cast iron. Looking at shaft end, rotation is clockwise. As a compressor, the pump includes a 1 in. pipe size automatic lubricator and intake filter. Used as a source of air pressure independent of plant air lines, the pulseless air delivery of rotary design is said to eliminate need for an air tank.

Weight of pump with accessories, without base, is 92 lb. Gast Mfg. Corp., Benton Harbor, Mich.

For more information—
see Booth 1828, Design Engineering Show

Inertia Switch

An omnidirectional inertia switch, which operates at any unusual jolt or impact, was originally designed for aircraft safety applications, such as for switching on escape lights, shutting off power and fuel, and operating fire extinguishers. A button on the side allows the batteries to be tested whenever desired. Another button at the top is the reset button, which shuts off the light after it has been turned on by the inertia switch. Micro Switch, Div. Minneapolis-Honeywell Co., Freeport, Ill.

For more information—
see Booth 744, Design Engineering Show

Adjustable Sealed Switch

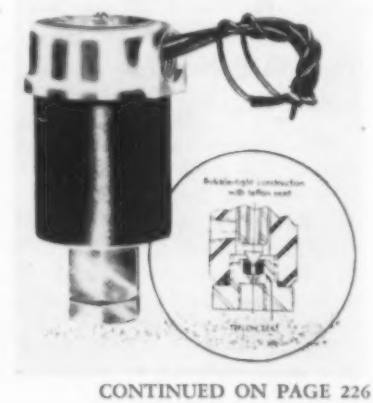
This snap switch was designed for aircraft controls. It is said to be unaffected by altitude change, humidity, temperature cycling or ice. Control is assured by the tipping action of the actuator.

When the tapered rubber collar is tightened by the connector, it seals the wire connections and terminals against condensation. Actuator adjustment through 14° is possible. This permits more precise switch settings for exacting electrical control. Adjustment of the locknut controlling the actuator can be done with one hand, and, at the same time, testing for the desired setting with the other hand. Weight is 8 oz max. Rating is 10 amp at 125/250 v a-c, 28 v d-c inductive. Temperature range is −100 F to 250 F. Electro-Snap Switch & Mfg. Co., 4218 W. Lake St., Chicago 24, Ill.

For more information—
see Booth 701, Design Engineering Show

Stainless Steel Solenoid Valve

A solenoid valve that is bubbletight at 5000 psi is of the direct-lift, angle-type, machined from Type 316 stainless steel bar stock. A Teflon seat eliminates metal-to-metal seal.

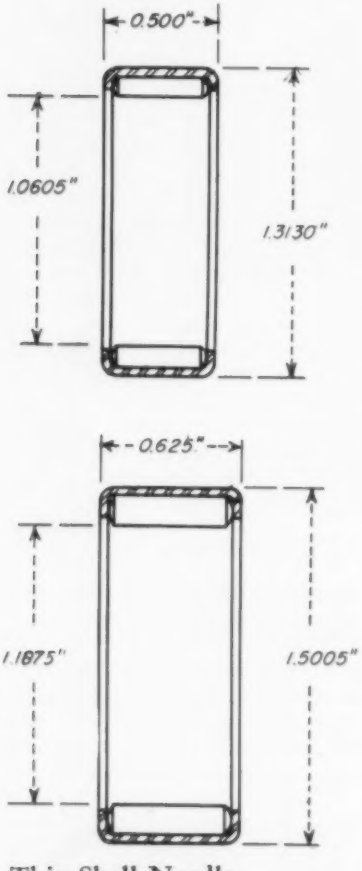


CONTINUED ON PAGE 226

The valve is said to be suited to applications where high pressure is combined with relatively little flow. Its direct lift action provides instantaneous opening and closing even with viscous fluids.

Pipe sizes are $\frac{1}{8}$ and $\frac{1}{4}$ in., with $\frac{7}{32}$, $\frac{5}{32}$, $\frac{1}{8}$ or $\frac{7}{16}$ in. port sizes. Coils are available in any voltage desired. Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis 25, Ind.

For more information—
see Booth 1807, Design Engineering Show

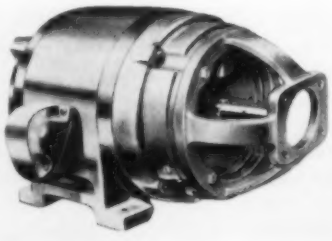


Thin-Shell Needle Roller Bearings

This bearing uses spherical-end rollers. The shells are made of SAE 1010 steel, hardened to 60 Rc min. The rollers are made of SAE 50100 steel, also harderned to Rockwell 60 Rc. These bearings are used with shafts of the same hardness to obtain maximum capacity and life.

Two sizes are now in production, with shaft diameters of 1.0105 and 1.1875 in. The rollers come assembled in their shells and are retained by a special purpose grease, which is also a satisfactory lubricant. It is readily soluble in automatic transmission oil. Kaydon Engineering Corp., McCracken St., Muskegon, Mich.

For more information—
see Booth 1724, Design Engineering Show



Motors For Hydraulic Pumps

These motors, available in dripproof, totally-enclosed, and explosionproof designs, use a face-type registered bracket for mounting the pump on the motor. In the dripproof enclosure, these motors are available to 125 hp. Totally-enclosed and explosionproof designs are available to 125 hp. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

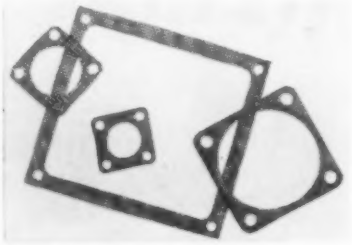
For more information—
see Booth 1644, Design Engineering Show

Conductive, Shielding Gasket Material

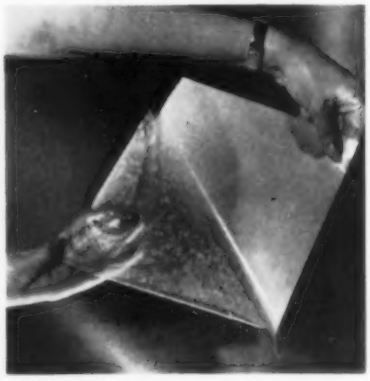
The material is made of flexible aluminum wire cloth impregnated with neoprene. It is manufactured in two thicknesses, 0.016 and 0.020 in., in rolls 8 in. wide. Gaskets cut to specifications are also available.

This material is intended to provide maximum rf shielding and pressure sealing characteristics. It is said to provide an air seal, yet conduct high frequency currents, preventing leakage which might affect radio and electronic operations.

The aluminum-neoprene combination is already in use as shielding gaskets in standard AN connectors, for mounting motors on radio antennas, and magnetos on aircraft engines with ignition harnesses and leads, and for flange-mounted connectors on aircraft tanks, trucks and buses. Auburn Mfg. Co., Middletown, Conn.



For more information—
see Booth 212, Design Engineering Show



Pressure-sensitive Adhesive Film

These film adhesives consist of porous, essentially transparent paper carriers, which have been saturated and coated on both sides with a clear super-aging adhesive. The film is tacky on both sides. For handling, the films are wound up with a coated glassine-type release paper on one side only.

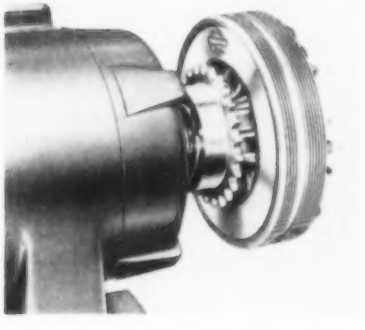
These film adhesives have been specifically developed for use on flat surfaces where intimate and complete contact can be made between the film and the materials to be bonded. As with pressure-sensitive liquid adhesives, the resultant bond is not meant to sustain severe creep stresses. Two types of film are produced. Type A is relatively soft, recommended for use on porous or semi-porous surfaces where adhesive flow is desirable. Type B is firmer than Type A and has restricted flow.

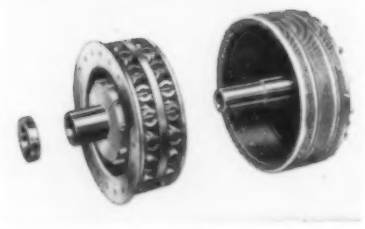
Good adhesion has been observed to polystyrene, polyethylene, cellulose

acetate, cellulose acetate butyrate, Mylar, metallized Mylar, vinyl (both plasticized and unplasticized), cellulose triacetate, and Saran-coated cellophane, as well as to a wide variety of non-plastics. Adhesion to various surfaces is said to be well over 30 oz per inch. The adhesion to the release paper is on the order of 6 oz per inch.

Standard width is 36 in., nominal. Standard length is 100 yd. rolls. Weight per 100 yd roll is 25 lb. Thickness, not including release paper, is 0.004 to 0.006 in. Rubber & Asbestos Corp., 225 Belleville Ave., Bloomfield, N. J.

For more information—
see Booth 8, Design Engineering Show





Magnetic Clutch for 1 to 15 Hp Applications

This clutch consists of two basic components. One is a magnetic rotor, a cylinder to which are attached permanent magnets. The other is also a rotor, consisting of a copper-faced mild steel cylinder perforated with steel rivets.

Mounted with an airgap in between, the bimetallic rotor is the driving member, always rotating at motor speed. The resulting eddy currents, with the permanent magnets providing flux, provide the torque required to rotate the inner, driven rotor. Driving and driven members are never in contact.

This magnetic drive can be run in full stall (100% slip) indefinitely, without harm to motor or coupling. A motor driven by this unit can be instantly reversed under full load and used as a brake. In the stalled condition, all input horsepower develops as heat.

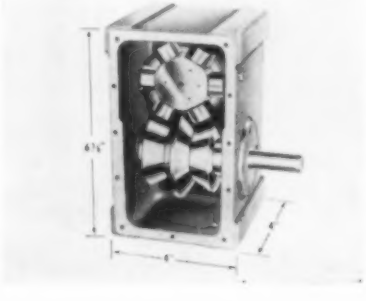
With an input of 1 hp, operating torque is 3 ft-lb and dimensions are $4\frac{3}{8}$ x $8\frac{3}{4}$ in. dia, with 2 in. dia output shaft. At 15 hp input, torque rating is 45 ft-lb, dimensions $8\frac{1}{4}$ x $13\frac{3}{4}$ in. dia, $3\frac{5}{16}$ in. dia shaft. Whitney Chain Co., 237 Hamilton St., Hartford 2, Conn.

For more information—
see Booth 322, Design Engineering Show

Roller Gear Drives for Up to 2000 Indexes a Minute

These drives, rated at 2000 indexes a minute, are designed for packaging, photographic, pharmaceutical equipment and instrumentation. Components of the mechanism include a hardened tool steel cam with a tapered rib and hub with standard bearing followers.

Two followers are in contact with the cam rib at all times. As the cam rotates, a curved portion of the rib indexes the hub and output shaft. When the followers reach a straight section of the rib, dwell occurs and the hub is locked, with a precision of 0.001 in. and zero backlash without auxiliary locking or locating methods. The units are rated for a minimum of 8000 hr. and employ a modified trapezoid acceleration characteristic. The F Series drives are available from stock with 3, 4, 6, 8 and 12 stops and with indexing periods of 120, 180 and 270 deg. Housings are as small as $6\frac{3}{8}$ x 4 x 4 in. Ferguson Machine Corp. of Ind., P. O. Box 5841, St. Louis 21, Mo.



For more information—
see Booth 306, Design Engineering Show

Rotating Joint Handles Up to Four Fluids

These joints allow eccentric rotation of both inner and outer rotating members about independent centers. There is said to be no binding between the two rotating members to cause leakage and eventual fatigue failure.

A method of fastening rotating syphon tubes into a manifold makes possible the transmission of up to four different fluids through the rotary joint without leakage between passages. Joints in $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, 2 in. sizes are available. Rotherm Engineering Co., Inc., 7280 W. Devon Ave., Chicago 31, Ill.

For more information—
see Booth 402, Design Engineering Show

Wide Temperature Range Lubricants

This lubricant was developed to meet the needs of military equipment. Its high properties are particularly useful where lubrication and oxidation stability are of paramount importance. Film strength and load-carrying properties are said to be doubled. Volatility is 25% of comparable materials and viscosity level is twice as high.

CONTINUED ON PAGE 228

The new lubricant is usable from −40 to 500 F under continuous operation, and as high as 650 F for short periods of time. No deterioration or sludge develops in this temperature range. Lehigh Chemical Co., Chestertown, Md.

For more information—
see Booth 305-307, Design Engineering Show

Heavy Duty Foot Switches

Both maintained and momentary contact switches are included, and single, two and three-stage types are available in both series. General purpose housings, as well as watertight, explosionproof and high d-c rated (125 v d-c, 10 amp) models are produced.

A-c rating is 125 to 480 v, 20 amp. Cast iron housings with safety guards are used on all switches, which are UL-approved. Linemaster Switch Corp., Woodstock, Conn.

For more information—
see Booth 407, Design Engineering Show

Screen-backed Plastic Bearings

This is the latest in a series of modified Teflon products developed primarily as a sleeve bearing material. It provides a PV rating of 20,000 in non-lubricated, continuous, unidirectional service. Required shaft clearances are 0.0005 in., said to be a considerable reduction in clearance necessary with Teflon bearings that are not screen-backed.

This backing is a 70 x 70 phosphor bronze mesh. The plastic component is locked into one face of the screen, with the other side left free to facilitate bonding to a back-up material. The screen can be made of stainless steel, copper, aluminum and other metals. The Teflon thickness can be as low as 0.005 in., and by laminating multiple layers of filled screening, as high as ½ in. The plastic can also be applied to both sides of the screening.

Service temperature range of the new bearing is said to be −400 F to 500 F. This relatively high temperature limit is due to the heat conducting characteristics of the screen backing. Moisture absorption is zero, which indicates the bearings can be used in liquids. Dixon Corp., Bristol, R. I.

For more information—
see Booth 321, Design Engineering Show

Flexible Drive Shaft

A 1¼ in. drive shaft has a 1¼ dia core, made of wound high carbon wire. The casing is rubber with an oil-tempered spring steel liner, reinforced with wire braids. Sleeve bearings are furnished on each end and couplings can be obtained for attaching to any power take-off shaft. Stow Mfg. Co., 443 State St., Binghamton, N. Y.

For more information—
see Booth 302, Design Engineering Show

Power-and-Control Package

This is a start-stop power drive and cyclic control device which is said to provide all cyclic operational functions for machine-starting, stopping, inching, positioning, holding, acceleration control, deceleration control and torque limiting. During the power drive phase of each cycle the unit also functions as a power transmission. A continuously running electric motor provides driving power and kinetic energy.

Various types of remote switching devices may be used, either manual or automatic, and a choice between innumerable sequencing circuits will provide any extent of automatic control. These switches and circuits carry only the electro-magnetic energizing current, less than ½ amp for sizes rated to 50 hp. No mechanical, hydraulic or pneumatic accessory devices are required.

All five available sizes are with foot, flange or face mounting facilities compatible with NEMA electric motor dimensions. There are also open, splashproof and totally enclosed housings.

The new drive's input shaft is driven by the electric motor, usually through a direct coupling or a belt drive. The output shaft, in turn, drives the machine. As this permits the drive motor to rotate continuously, regardless of the start-stop action of the machine, it is possible to use the motor rotor as a supplemental flywheel. Cycledynamics Inc., 19025 W. Davison, Detroit 23, Mich.

For more information—
see Booth 1227, Design Engineering Show

Switching and Gain Control For Read-out Instruments

This bridge goes between SR-4 strain gages, accelerometers and pressure pickups and a whole group of read-out instruments in the 10 milliv sensitivity range. These instruments include indicators, strip chart recorders, digital mechanisms and oscilloscopes.

These switching units will prebalance and preset the gain on each chan-

nel, so that each channel can be switched in at will. Thus there is only one channel reading load, one reading stress and one reading pressure, and they can all be set so that the indicator or chart recorder or oscilloscope is reading directly in the desired units, rather than, for example, all coming out in strain values which later have to be interpreted. There is a built-in calibration system which makes it easy to have the calibration value for any transducer readily available.

The bridge operates off the power line. Ellis Associates, Box 77, Pelham, N. Y.

For more information—
see Booth 829, Design Engineering Show

L-Shaped Table-desk Combination

The reference section of this engineering furniture unit has a linoleum surface. The drawing board operates on a 20-in. vertical board travel mount

with tilt capabilities from horizontal to vertical. It can be used when standing or seated, and regardless of board position, there is said to be adequate leg room. Hamilton Mfg. Co., Two Rivers, Wis.

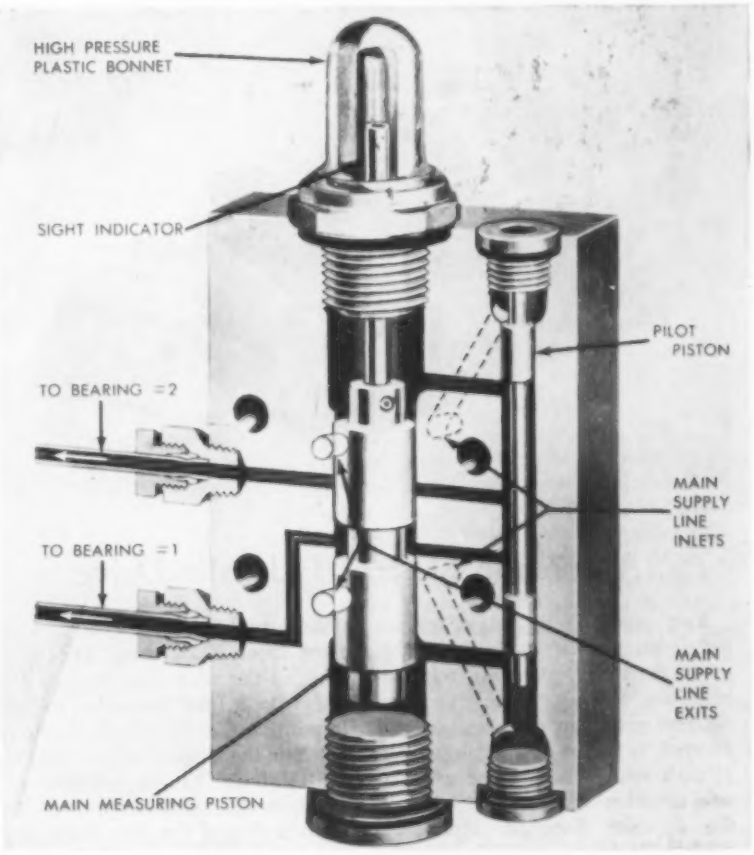
For more information—
see Booth 1648, Design Engineering Show

Stress Evaluation Kit

This method of determining stress employs a brittle lacquer coating, which is sprayed on the part to be tested and allowed to dry. When dry, the part is loaded. Crack patterns of the brittle coating indicate the relative stress concentration on the part, permitting analysis of residual and dynamic stresses.

The kit includes all materials and apparatus necessary for making quantitative as well as qualitative analyses. Metal cabinet contains spray gun, coatings, thinners, air gage, compressor air hose, gas mask, flashlight, calibration strips, strain scale, selection chart, and sling psychometer. Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

For more information—
see Booth 827, Design Engineering Show



Circulating Oil Lubrication System

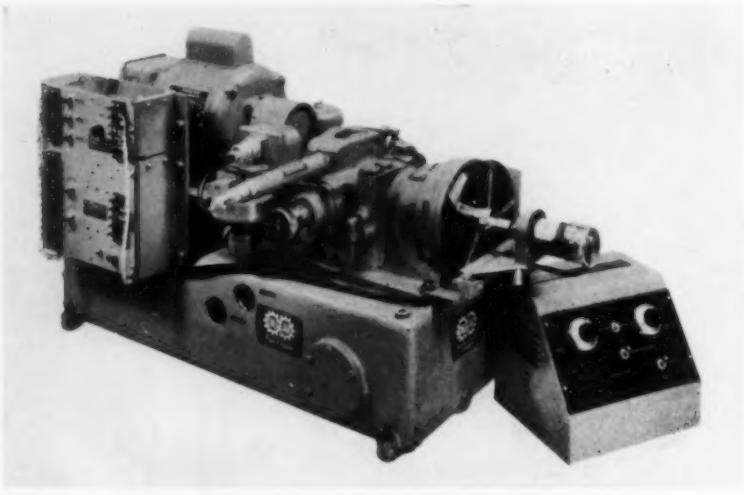
Designed for presses, automatic and semi-automatic machine tools, this system employs a two-line principle of operation to supply oil under pressure to measuring valves for delivery to bearing points. The valves have individual sight indicators and use the positive piston displacement method of feeding lubricant.

The system monitors its own operation through a pressure-sensing mechanism, to warn of clogged or broken lines. A variable delivery pumping unit permits selection of the number of injections per minute applied to bearing points at various locations.

There is no limit to the number of measuring valves that can be assembled together to serve a piece of equipment, and the valves are manufactured in two capacities for interchangeable installation as required. In addition, since each valve is designed to serve two bearings, an external cross-porting accessory can be attached at any time to merge two discharge ports into one. Farval Corp., 3249 E. 80 St., Cleveland, Ohio.

For more information—
see Booth 222-224, Design Engineering Show

CONTINUED ON PAGE 230



Automatic Electro-Hydraulic Drive

Two speed dials and a selector switch on the control unit of this drive provide for various selection functions: 1) Dials may be set for two different speeds in one direction and selected by means of a toggle switch; 2) dials may be set for one speed in one direction and another speed in the opposite direction; reversal is available instantaneously through the toggle switch; 3) dials may be manually adjusted, resulting in stepless speed variation in either direction.

Instantaneous position control is available through another toggle switch in the command unit. Precise stopping positions can be selected at will with the dial from an infinite range of 360°.

An electric signal from the speed control is transmitted to the amplifier. The amplifier unit is provided with gain adjustments to allow independent control of two separate input signals. The signal to the amplifier is transmitted to the servo valve, which controls the flow of fluid to or from the transmission control cylinder. The control piston positions the slide block in the transmission to provide the desired volume and direction of fluid flow to the output drive unit.

The transmission is equipped with a linear variable differential transformer, which produces an electrical signal proportional to slide block movement. If slide block voltage is not identical to command voltage, the valve spool is actuated. The movement of the valve spool permits fluid to flow to or from the control cylinder to position the slide block. Any error between the original signal from the control board to the amplifier unit and from the transducer will result in repositioning of the slide block. Output remains nearly constant. Accuracies from 0.1 to 1.5% are claimed.

The output shaft is connected directly to the synchro. A feedback signal is fed to the control section and compared to the original signal. Any error will signal the servo valve and the output shaft is positioned accordingly. This feedback circuit is in operation only when the position circuit is energized. Servocontrol, Div. Oilgear Co., Waltham, Mass.

For more information—
See booth 1740, Design Engineering Show

Over-running Spring Clutches

These over-running clutches include ball bearing and sleeve bearing types. The ball-bearing clutches are designed for 20 to 3000 ft-lb torque capacity and shaft sizes of ⅜ to 3 in. The sleeve-bearing clutches are offered in the 20 to 100 in-lb torque range, for shafts of ⅛ to ½ in.

Both clutches are suitable for over-running, indexing and backstopping applications. They are positive action clutches for high speeds. Marquette Div., Curtiss-Wright Corp., 1145 Galewood Dr., Cleveland 10, Ohio.

For more information—
See booth 918, Design Engineering Show

Self-wicking Liquid Lubricant

This is a combination of oil and cellulose-base fibers. These materials are chemically blended to form a single, self-wicking, liquid lubricant.

Because the material is a fluid, it is said to be able to flow and completely fill any size sleeve bearing cavity, regardless of shape. Because this lubricant will not separate under injection pressure, it provides a practical means of inserting wicking material and lubricant in one operation.

Until now, the only system for metering lubricant to sleeve bearings has been the use of die-cut felts and wool and cotton wastes. They must be inserted by hand. The new oil-fiber combination can be injected by machine. Fluidwick Co., 5319 E. Outer Dr., Detroit 34, Mich.

For more information—
See booth 536, Design Engineering Show

Flareless High-pressure Tube Fitting

This fitting is designed for use with the new SAE O-ring boss. The O-ring seal is also designed for air application and has been tested to operate at temperatures from −65 F to 212 F.

The fitting is specifically designed for high-pressure systems and is stocked in 31 styles and from ¼ to 2 in. Weatherhead Co., 128 W. Washington Blvd., Fort Wayne, Ind.

For more information—
See booth 332, Design Engineering Show

Increment Start Motor

This is a four-pole, 220 v. 1800 rpm motor available from 20 hp and up. It is designed for service requiring an increment start motor, but the cost is the same as a standard motor. Brook Motor Corp., 3555-57 W. Peterson Ave., Chicago 45, Ill.

For more information—
See Booth 23, Design Engineering Show

CMP

RESTRICTED SPECIFICATION COLD ROLLED STRIP STEEL

for Spring Steel Requirements such as these . . .

FORMED PARTS FOR HEAT TREATMENT

SIZE	8 x .036
ANALYSIS	1050
FINISH	Bright
HARDNESS	Rockwell B-78 Max.
THICKNESS TOLERANCE	± .0003 incl. crown
WIDTH TOLERANCE	± .005
MICROSTRUCTURE	Uniform spheroids
COIL SIZE	16" I.D. coils large as possible
PACKAGING	On skids — shrouded

FLAT PARTS FOR HIGH STRENGTH WITHOUT HEAT TREATMENT

SIZE	10 x .020
ANALYSIS	1075
FINISH	Bright
HARDNESS	Rockwell C-30 Min.
THICKNESS TOLERANCE	± .001 incl. crown
WIDTH TOLERANCE	± .005
MICROSTRUCTURE	Small-fine carbides
COIL SIZE	16" — I.D. Max. coil wt. 1000#
PACKAGING	On skids — shrouded

Knowing exactly what you require for most efficient fabrication and most effective product performance, CMP can set up and consistently meet restricted specifications to match your most exacting demands. Often production operations can be greatly simplified or even eliminated; in most instances end-product and/or assembly costs can be reduced and quite frequently, product quality improved.

We would welcome an opportunity to explore with you the possibilities of CMP Restricted Specifications applied to your strip steel requirements.

THE 3 IN 1 SOURCE FOR YOUR

COLD ROLLED STRIP STEEL

Now there are three CMP plants with facilities for production of "Restricted Specification" cold rolled strip. Strategic locations at Youngstown, Indianapolis and Los Angeles, provide the security of 3 sources of supply plus the close working relationship which these local production centers make possible.

SIZE	14 x .840
ANALYSIS	1095
FINISH	Bright
HARDNESS	95 to 105 Rockwell B suitable for blanking
THICKNESS TOLERANCE	± .0005 incl. crown
WIDTH TOLERANCE	± .005
MICROSTRUCTURE	Uniform medium size spheroids
COIL SIZE	16" — I.D. Max. coil wt. 800#
PACKAGING	On skids — shrouded

CMP

THE COLD METAL PRODUCTS CO.
GENERAL OFFICES: YOUNGSTOWN 1, OHIO
PLANTS: YOUNGSTOWN, INDIANAPOLIS AND LOS ANGELES
SALES OFFICES: NEW YORK - CLEVELAND - DETROIT - INDIANAPOLIS
CHICAGO - LOS ANGELES - SAN FRANCISCO

NEW COMPONENTS

Nylon Batting Used for Vibration, Thermal Insulation

A self-supporting batting made of nylon fibers has characteristics useful for thermal insulation, liquid and gaseous filtration, vibration and shock absorption. As a filtering medium, different degrees of separation can be achieved by using different denier fibers in the fabric or by using blends of deniers. As a vibration absorber, tests show that a ¼ in. thick piece of the new material will absorb virtually all of the vibrations induced in a table while unmounted objects produce severe surface and lateral motion. As a shock absorber, the material seems to have desirable advantages because of its ability to soften an impact while recovering to its normal shape without undue force.

The batting possesses all of nylon's properties, including being acid, alkali, fungus and mildew resistant, and possessing rapid drying characteristics. Since it will withstand continuous temperatures of 300 F, it can be laminated or stitched by heat processes.

The material is made by crimping nylon fibers and then permanently locking them together by a chemical-thermal process. The fiber crimp gives the fabric added tensile strength and loft as well as imparting permanent resilience. The material is produced in a range of weights from 2 to 8 oz per sq yd. It is available in any width up to 55 in. Star Woolen Co., Cohoes, N. Y.

For more information—
Circle 1, inside back cover

Brakes with 125 to 650 ft-lb Torque Rating

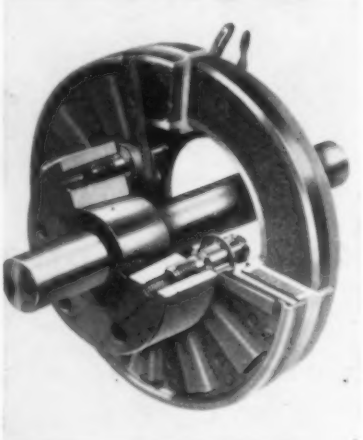
A line of brakes that combines high torque and fast cycling with the ability to hold or stop a load if power fails are essentially two brakes in one. Four basic sizes of brakes are currently listed as standard. Power torque ratings range from 125 to 650 ft-lb, and fail-safe torque ratings from 33 to 205 ft-lb. Models are also available that provide the fail-safe feature with electrical release, but without power braking.

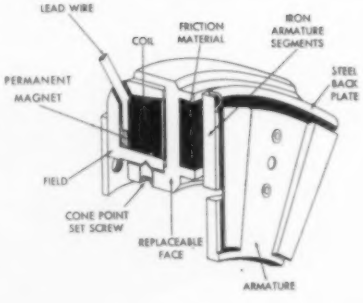
The entire brake has a minmum number of moving parts, with no moving parts in the fail-safe mechanism. There is no friction in the field or magnets. All that ever has to be replaced is the face and the armature. The brakes are said to be self-adjusting for wear and require no bands, links, cams, or adjusting screws.

With a special adapter, the new brakes can be mounted on any NEMA C flange and used as a motor brake for a variety of machinery applications. Fast stop-start control for all types of industrial equipment is possible when these brakes are coupled with the manufacturer's electric clutch.

The brake consists of a stationary field, replaceable face and armature. A ring of permanent magnets imbedded in the face of the field provides the fail-safe feature that holds the brake in position with power turned off, or in the event of power failure. Flux path with power off is concentrated through the armature because the field shell which offers the alternate path is designed with a higher reluctance or resistance to the magnetic flux.

The wound coil located in the field also produces magnetic lines of force,





with their direction depending on how the coil is connected to the d-c power supply. To release the brake, current is passed through the coil so that its magnetic field is set up in the same direction as that of the permanent magnets. This results in building up the flux path through the permanent magnet and the field shell while decreasing the flux through the armature. The attraction between the armature and the replaceable face is weakened to the point that the release springs in the autogap accessory push the armature clear, effectively releasing the brake. Warner Electric Brake & Clutch Co., Beloit, Wis.

For more information—
Circle 2, inside back cover

Time Delay Air Valve

This valve is for applications requiring a time delay between the release of the electrical impulse to the solenoid of the air valve and the return of the cylinder to its original position. Delay time is adjustable between 0 and 30 sec, with a repetition accuracy of ±10%. The time delay is built into the valve so that it requires no special switching to accomplish the time lag.

This valve is available in ¼ through 1 in. ports. Beckett-Harcum Co., 1087 Wayne Road, Wilmington, Ohio.

For more information—
Circle 3, inside back cover

Dimetric Protractor

This protractor is based on a scale ratio of 1:1:0.5. It is made of clear vinyl and contains complete graduations of 180° each, for the two different scale sections of the dimetric system. The numerals cover 90° from the zero mark, both in clockwise and counter-clockwise direction.

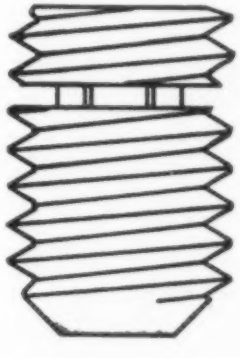
Since the material of the protractor is transparent and may be used in regular and in reversed position, a second set of numerals is provided in reversed figures, so that the numerals can be read directly in regular as well as in reverse position. The edges are cut so that by placing any edge against a T-square or drafting machine edge, the protractor is automatically oriented in correct position. A dimetric half-square in every half of the protractor helps placing the protractor on the drawing in proper relation.

A pair of half-ellipses of 2 in. size can be used for determining the dimetric length of lines extending in angular directions not parallel with the main axes of the dimetric system. John R. Cassell Co., Inc., 110 W. 42 St., New York 36, N. Y.

For more information—
Circle 4, inside back cover

Self-Locking Socket Set Screw

A self-locking, one-piece screw which is actually two screws in one is installed with a regular hex wrench. Wrench is inserted in bottom of socket and lower section of fastening is tightened. Tool is then raised so that it contacts only upper section and this part is then tightened separately. A thin, shell-like connection between upper and lower section then fractures and top section is pulled up all the way.



The screw is re-usable. It is available in No. 6, 8, 10, ¼, 5/16, ⅜ in. sizes, in a variety of lengths. Sta-Loc Inc., 1319 Widergren, Rockford, Ill.

For more information—
Circle 5, inside back cover

FLUID POWER, CONTROL

Hydraulic System Pump

A variable delivery axial multiplunger pump develops 5700 psi and is intended for hydraulic applications. The oil delivery of this pump can be manually adjusted to any desired value (within available range) or can be left to vary automatically inversely with pressure-changes. This is said to provide savings in power, especially during holding stages of an operating cycle, when only limited delivery is required to maintain the preset maximum pressure.

Sizes from 1½ to 30 hp are offered either as pumps or as packaged power units. Equi-Flow Div., Vibro Mfg. Co., Inc., Woodside, N. Y.

For more information—
Circle 6, inside back cover

Rotary Hydraulic Actuator

For use in positional control servo systems at fluid supply pressures in the 3000 to 4500 psi range, this hydraulic actuator is said to provide static breakaway friction of less than 1% of maximum stall torque, low internal leakage and minimum load coupling compliance. Captive cylindrical elements are located in receptive semi-cylindrical grooves for both stationary and moving vanes. Cylindrical vane members are supported uniformly along entire length and are unrestrained rotationally. Configuration minimizes load-induced structural distortion and permits effective sealing at both the stationary and

CONTINUED ON PAGE 234

moving vanes, despite pressure-induced radial expansion of the stator.

The device is offered from 100 to 6000 in-lb stall torque (at 3000 psi supply pressure). Kelsey-Hayes Co., Detroit 32, Mich.

For more information—
Circle 7, inside back cover

All-Air Control Circuit

An all-air safety circuit for presses, brakes, shears and other machines uses a non-tie-down special purpose valve, a single stroke valve and a three-way poppet palm button valve arrangement. The non-tie-down valve was designed with a protected adjusting screw. The regulation of this screw permits a variable time lag between the depression of the first palm button valve and the second palm button valve.

The non-tie-down valve has been so designed that its own malfunctioning due to fatigue failure or foreign matter will automatically cause the system to become inoperative.

Components can be added to provide following functions: emergency stop—used to stop the press at any point of its stroke; continuous—used when press is put on automatic cycling and material is fed through the press continuously; top stop—permitting stopping of the press run at the top dead center position after the press has been running on continuous cycle; inching—permitting starting and stopping the press at will during setup operations; pneumatic interlock—permitting the operator to release control buttons on single stroke operation before the full stroke is completed without having the press stop until the run is at top dead center; selector valve—used to pre-select any one of the desired press cycles thus permitting the press to be actuated only with the type operation selected for specific jobs. Ross Operating Valve Co., 134 E. Golden Gate Ave., Detroit 3, Mich.

For more information—
Circle 8, inside back cover

Lightweight Pump

This pump measures 8 x 3 in. dia and weighs about 3 lb. Operating from 400 cps current, the units meet applicable military specifications.

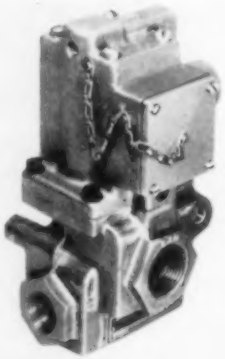
Typical applications of these sealless pumps include leakproof circulation of coolants in airborne radar equipment, coolant circulation in missile hydraulic fluids. Applied Dynamics Corp., 32 N. Main St., Natick, Mass.

For more information—
Circle 9, inside back cover

Solenoid-Controlled Air Valve

This pilot-operated, poppet-type valve meets all JIC standards, including a watertight and dusttight solenoid enclosure. A recessed pin, which can be locked in or locked out makes it possible to operate the valve manually, without removing cover.

In-line cylinder and inlet ports



permit mounting valve directly on cylinder.

These valves are furnished in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$ in. sizes, either normally open or normally closed, with continuous duty solenoids. Automatic Valve Co., 37415 Grand River Ave., Farmington, Mich.

For more information—
Circle 10, inside back cover

Control Valve Actuators

A line of all-metal actuators for control valves for use under difficult conditions such as atomic radiation, high temperatures and corrosion have been designed for both pneumatic and hydraulic control systems. The actuators are available with suitable valves as complex control units, or as additions to existing valve installations. Some are designed to function either air-to-open or air-to-close and are easily reversible in the field.

Various models are made partly

CONTINUED ON PAGE 236

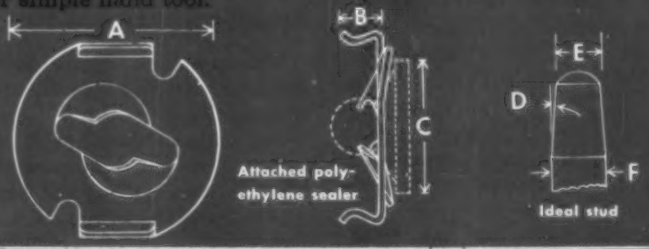
DOT THREAD CUTTING FASTENER HOLDS TIGHT TO CURVED SURFACES

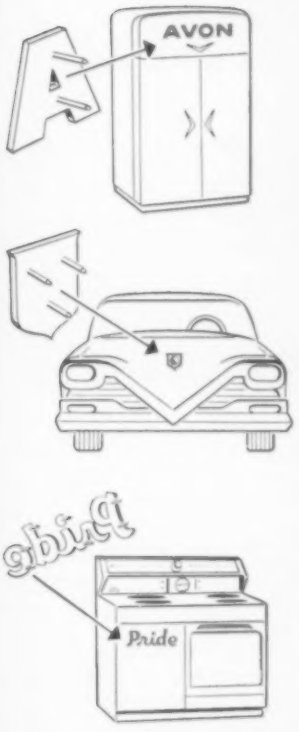
- Low Cost
- Re-Usable
- Self-Locking
- Vibration-Proof
- Spring Take-Up

Specially designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces . . . DOT'S unique T.C.F. can be used in many other applications which require a spring take-up fastener that pulls up tight without backup on flat or contoured surfaces.

It cuts clean, deep threads on unthreaded studs, even those that are chrome plated. When used with its preassembled plastic sealer, T.C.F. makes a water-tight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

Available *in quantity*, with or without sealer, to fit 1/8" and 3/16" studs. Drawings available on request for magnetic tool or simple hand tool.





Nominal Sizes	A	B	C	D	E	F	Driving Torque	Ultimate Strength
1/8"	.560	.170	.450	6°/4°	.095 .085	.130 .125	7-10 Inch lbs.	200 lbs.
3/16"	.705	.200	.450	6°/3°	.160 .150	.192 .184	20 - 30 Inch lbs.	400 lbs.

SEE US AT BOOTH 1044 DESIGN ENGINEERING SHOW

Manufactured by
MONADNOCK MILLS SUBSIDIARY
San Leandro, Cal.

DOT T.C.F.
Patent Pending

Manufactured by
CARR FASTENER CO. DIVISION
Cambridge, Mass.

UNITED-CARR FASTENER CORPORATION

or entirely of stainless steel, and are available in three ranges of signal pressures: 3 to 15 psi; 6 to 30 psi; 9 to 45 psi. Possessing a maximum thrust of about 3000 lb, the actuator measures 17⅛ x 8⅝ in. dia. Fulton Sylphon Div. Robertshaw-Fulton Controls Co., Box 400, Knoxville 1, Tenn.

For more information—
Circle 11, inside back cover

Manually Operated Pressure Regulator

Inlet to regulator will accept stored air pressure up to 3500 psi. An adjusting handle regulates outlet or delivery pressure throughout an infinite number of increments from 0 to 3000 psi.

Regulator is of the spring-loaded, balance pressure type and incorporates an integral relief feature which permits upward or downward adjustment of delivery pressure without separate relief of the delivery pressure line. Materials are steel and aluminum.

With 3000 psi inlet pressure, pressure drop is less than 200 psi. Cornelius Co., 550-39 Ave., N. E., Minneapolis 21, Minn.

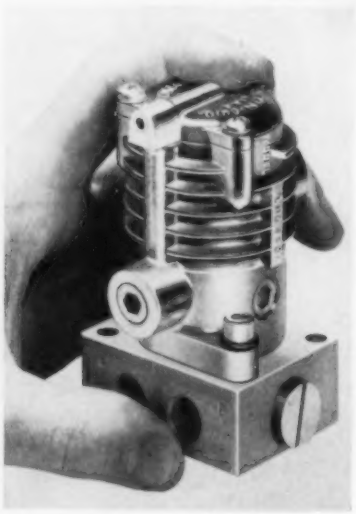
For more information—
Circle 12, inside back cover

Variable Volume Pump

Designed to JIC standards, these sub-plate mounted hydraulic pumps are for use in machine tool feed systems, hydraulic presses and mobile equipment, according to the manufacturer. The pump delivers 40 gpm at 1200 rpm. Pump is designed for 1000 psi continuous operating pressure and 1250 psi intermittent.

A volume selector adjustment is provided as standard equipment to adjust the pump delivery to circuit requirements. Automatic selection of two separately adjustable pressures can be obtained by the use of hydraulic or electrically controlled pressure compensating pump governors. Racine Hydraulics and Machinery, Inc., Racine, Wis.

For more information—
Circle 13, inside back cover



Pilot-operated Four-Way Valve

A miniature pilot-operated valve, for control of small double-acting cylinders and similar devices, is 4 in. high and weighs 30 oz. It has three working parts. Four-way action is achieved with a single solenoid pilot and a pressure-balanced shuttle in the valve body.

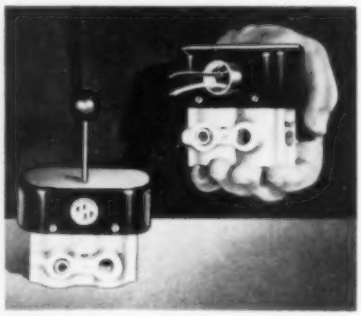
Solenoid pilot, with coils for a-c or d-c, any voltage, is interchangeable with standard pilots by this manufacturer and is built to JIC standards. Manual over-ride and integral junction box are optional features.

These valves are designed for two-point mounting. They may be used with pressures from 15 to 140 psi. All ports are tapped ¼ in. NPT. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio

For more information—
Circle 14, inside back cover

Four-way Quick-dump Valves

The valves are four-way, five-port units. There are no internal springs, packings, pistons, or sliding, metal-



to-metal contacts. Two of the new valves are electrically operated and the third is equipped with hand lever. The valves do not employ solenoids, but, instead, have electromagnetic armatures. Armature travel in actuating the valve is 0.022 in. This short throw, according to the manufacturer, eliminates hammering action and reduces wear. Humphrey Products Div., General Gas Light Co., Kalamazoo, Mich.

For more information—
Circle 15, inside back cover

ENGINEERING MATERIALS

Epoxy-impregnated Paper

This translucent material, both as-is and copper-clad, has been dip-soldered at temperatures as high as 520 F for 15 sec without blistering. It can be cold-punched in thicknesses up to ⅛ in. without cracking and has only 0.25% water absorption in a piece 1 x 3 x ⅛ after 24 in. in distilled water. The material is available in sheets 36 x 42 in., 36 x 48 in., and half-sizes of these sheets. New England Laminates Co., Inc., 481 Canal St., Stamford, Conn.

For more information—
Circle 16, inside back cover

Fluxless Aluminum Solder

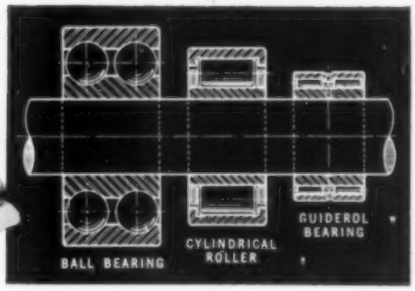
Characteristics of this solder indicate strength to 20,000 psi tensile in a mitered joint. The compound is

CONTINUED ON PAGE 238

BEARING TIPS by McGill

To pack more performance in smaller space

Use space-saving McGILL GUIDEROL® needle bearings

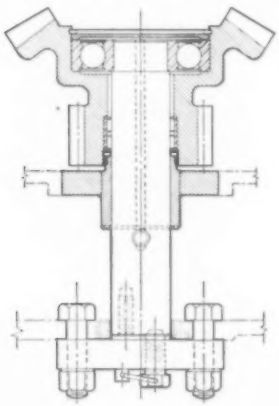


Showing graphically how a McGill GUIDEROL precision needle bearing permits more streamlined designing by supporting comparative loads in significantly smaller radial space than other types of bearings. Bulky and more costly housing space is easily avoided.

The McGill GUIDEROL Bearing combines the inherent high-load capacity of a full complement of full race width rollers with a center roller guiding principle that limits skewing and binding under misalignment. This qualifies the bearing for a whole range of applications that are too heavily loaded for a retainer-type bearing and are subject to the misalignment that precludes use of an ordinary needle bearing. For outstanding performance in small radial space, use GUIDEROL precision needle bearings. Specify the interchangeable sealed SGR series for added protection against contamination.

GUIDEROL® *bearing capacity, space economy proved in power shovel vertical reversing shaft assembly*

Baldwin - Lima - Hamilton Corp. uses a McGill GUIDEROL bearing, on ½ cubic yard power



shovels, to carry spur pinion loads in the vertical reversing shaft. The high capacity of the bearing in small radial space is an important factor in selection of this bearing. Only 3.75" in diameter, it has a load capacity of 28,560 lbs. at 100 rpm. In the power shovel application, it supports 14,150 lbs. at 76.3 rpm, which gives a high margin of safety. The center guided rollers also are especially adaptable to a vertical application such as this.

Fact-packed Bearing Catalog

Write for your copy of Catalog #52-A, a 128 page Bearing Selection Guide. It contains vital product information and 30 pages of engineering data.

Multiple spindle drill heads require support of spindles on very close centers

Crowding a great number of drill spindles into a small area, Zagar, Inc., of Cleveland has found the McGill GUIDEROL bearing construction especially suited to the needs of multiple drill head units. The full bearing width rollers provide rigidity and more than adequate load capacity and in a bearing only 1.25" in bore diameter.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

lead-free, and it is said there is no galvanic action between solder and base metal. Working temperature is 720 F, at which point the alloy flows freely. The alloy is rubbed on after heating the cleaned base metal enough so that the solder melts when applied. This tins the surface. Joining is accomplished by heating two tinned surfaces held firmly together. All-State Welding Alloys Co., Inc., 249-55 Ferris Ave., White Plains, N. Y.

For more information—
Circle 17, inside back cover

Heating Element Is Sprayed On

This is a controlled resistance compound applied to a base material in a liquid form by spraying, rolling, printing, screening, or dipping. The base material can be phenolic, glass, ceramic, asbestos, paper, glass cloth, metal or other materials. The coating remains as flexible as the base material to which it is applied. The material is permanently bonded to the base material and is moistureproof and oil and acid resistant. Thermflex Div., Verrall Moe Electronics Inc., 1008 Center St., Jefferson, Wis.

For more information—
Circle 18, inside back cover

Nylon Rod or Parts

Nylon is available as extruded rod or finished fabricated parts. Rod sizes range from ¼ through 2 in. dia, in 3 to 6 ft lengths. Nylon mechanical parts such as bearings, gears, cams, rollers, spools, worm wheels and bushings can also be supplied. National Vulcanized Fibre Co., 1057 Beech St., Wilmington 99, Del.

For more information—
Circle 19, inside back cover

Polysterene Molding Compound

Developed specifically for producing thin-walled articles with improved resistance to breakage, this compound is for use in fast-cycling, fully automatic injection molding equipment. It can be used in other types of molding machines as well. Bakelite Co., Div., Union Carbide & Carbon Corp., 260 Madison Ave., New York 16, N. Y.

For more information—
Circle 20, inside back cover

Wood Veneer

This is a wood veneer only 1/125 in. thick, with a protective surface that is scratch and stain-resistant and cannot be scorched. It is flexible, and can be bent right over any curved substrate, or even around a sharp corner. Available in roll or sheets, up to 24 in. wide. David Feldman & Assoc., Calle Barranquitas 51, Santurce, Puerto Rico.

For more information—
Circle 21, inside back cover

Plastic Shim and Gasket Stock

This material is supplied in shims, washers, gaskets, made to specification, or in roll stock. It comes in gages, from 0.001 to 0.030 in., each identified by its own color. Auburn Mfg. Co., Middletown, Conn.

For more information—
Circle 22, inside back cover

Silicone Rubber Compounds

Service temperatures to 500 F, and for limited periods to 600 F, are offered by five heat-resistant silicone compounds, with a Shore A hardness of 40 through 80. Three compounds with low shrinkage characteristics in the 50 through 70 durometer range permit the molding of parts and the holding of close tolerances in existing tools originally designed for organic rubbers.

Another silicon compound is available for parts that require exceptional electrical and physical properties at high temperatures. Acushnet Process Co., 768 Belleville Ave., New Bedford, Mass.

For more information—
Circle 23, inside back cover

Urethane Rubbers

These products are recommended for use in encapsulating electronic components, as impregnants for fibrous materials, and as adhesives and sealants. They are said to have excellent low temperature flexibility at −65 C, coupled with toughness and abrasion resistance. They are also self-extinguishing. Houghton Laboratories, Inc., Olean, N. Y.

For more information—
Circle 24, inside back cover

MECHANICAL COMPONENTS

Fractured Race Ball Bearings

Fracturing the outer ring of the bearing at one point is said to make it possible to open it sufficiently to introduce a maximum complement of balls. Advantages include no loss of thrust load-carrying capacity, increased load capacity and bearing life, one-piece retainer construction.

CONTINUED ON PAGE 240

FREE *new* BOOKLET *tells how to get* BETTER PAINT ADHESION

MAIL COUPON TODAY

TURCO PRODUCTS, INC.
6135 SOUTH CENTRAL AVE., LOS ANGELES 1, CALIF.

Please send me your free phosphating booklet and ready reference chart.

NAME_____

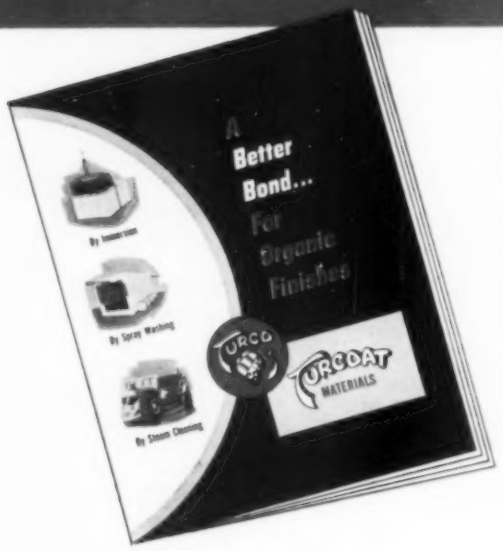
TITLE_____

FIRM_____

ADDRESS_____

*If other booklets described below are also desired, please enter numbers corresponding to booklets wanted*_____

PE



Complete PHOSPHATING Reference Chart includes:

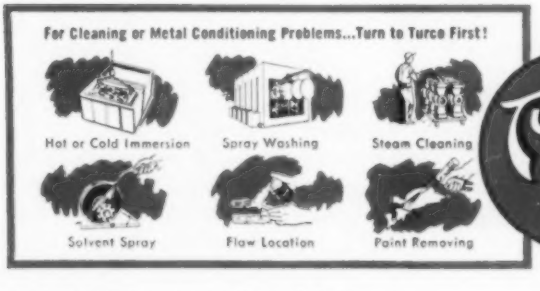
- Description of phosphating
- Diagram of how phosphating holds paint to metal
- Illustrations of what phosphating can do
- Types of coatings available
- Recommended uses
- Applicable Government Specifications
- Methods of application and equipment requirements
- Metals to be used on
- Coating weights
- Detailed operation cycles

Here...in the free Turcoat phosphating booklet... is the best solution to any paint adhesion problem. This new booklet describes the *complete* line of Turcoat materials—the coating compounds that assure *permanent* paint adhesion, slash rejects, require less complicated controls and are more economical to buy and use.

Only Turco offers a truly full line of government approved coating materials for use in *any* conceivable processing set-up prior to the use of organic finishes. Only Turco offers a staff of 160 technically trained representatives located in all parts of the country to give immediate 'round-the-clock service. No wonder Turco is adding new phosphating accounts at a phenomenal rate. There are many reasons why, when it comes to *paint adhesion*, more and more industrial concerns are turning to the Turcoat line. The Turcoat booklet lists them all.

BOOKLETS ALSO AVAILABLE ON:

1. Titanium Descaling
2. Stainless Steel Descaling
3. Magnesium Finishing
4. Hot Tank Cleaning
5. Dye Penetrant Inspections
6. Alkaline Rust Removing
7. Spray Washing
8. General Metal Working Compounds



TURCO PRODUCTS, INC.
Chemical Processing Compounds
6135 SOUTH CENTRAL AVE., LOS ANGELES 1, CALIF.

Factories: Newark, Chicago, Houston, Los Angeles, London, Rotterdam, Sydney, Mexico City, Naha (Okinawa)
Manufactured in Canada by B. W. Deane & Co., Montreal
Offices in all Principal Cities

The fractured ring is closed by its own resiliency and is secured by circumferential holding wires or rings. The manufacturer states that fracturing does not weaken the bearing. Split Ballbearing Corp., Lebanon, N. H.

For more information—
Circle 25, inside back cover

Leveling Jack

The jack supports up to 20 tons and raises or lowers by means of the adjustable nut. Compensation for floor slope is made by the concave spherical radius in the lift screw and aligning disc, which provides "float" and maintains horizontal alignment of the equipment.

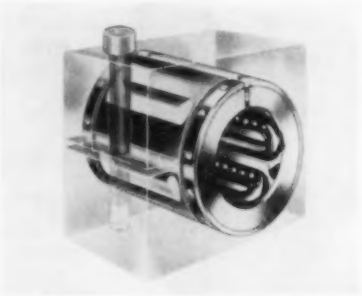
Machine vibration and creepage are minimized through the use of special mounting pads. Available in 12 models, ranging in height from 1¾ to 3¾ in. Leveling adjustment, ¾ in. Enterprise Machine Parts Corp., 2731 Jerome Ave., Detroit 12, Mich.

For more information—
Circle 26, inside back cover

Adjustable Diameter Linear Bearing

The bearings are split longitudinally and are designed to provide line-to-line or slight preload fits when mounted in an adjustable diameter housing. Free-running no-play linear motion is said to be provided, as the adjustable housing permits the tolerance on both the shaft diameter itself and bearing bore is to eliminated. The principle is also expected to make it possible to provide for compensation for wear.

These bushings or bearings are available in standard sizes for shaft

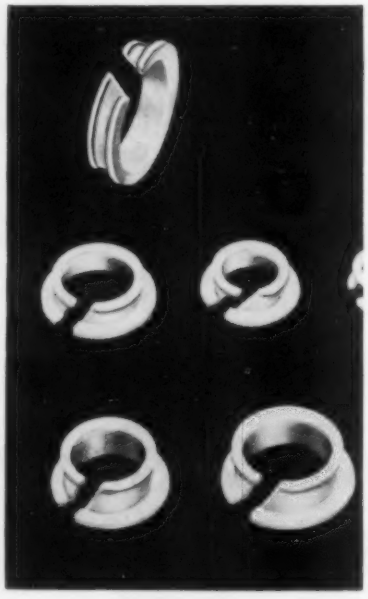


diameters ranging from 1 to 4 in. Thomson Industries, Inc., Manhasset, N. Y.

For more information—
Circle 27, inside back cover

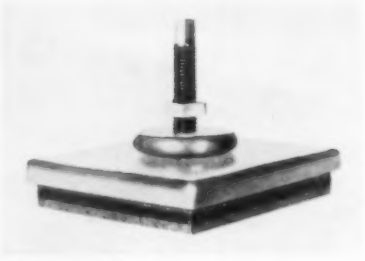
Nylon Bearing Liners

These bearings have a flange on both ends which retains the bearing in a hole in sheet metal or thin plates of any material. One of the flanges has sufficient area to take thrust loads that frequently exist. The bearings are provided with a helical split called a compensation gap which is equal in width to the expansion and contraction of nylon due to temperature changes and moisture absorption. This prevents changes in the bore diameter that would otherwise occur and therefore permits close fits of the shaft to the bearing.



These liners are manufactured in two lengths, one for plate thickness from 0.040 to 0.75 in. and the other for thicknesses from 0.072 to 0.135 in. There are nine sizes of each and the bore diameters range from ⅛ to ¾ in. Thomson Industries, Inc., Manhasset, N. Y.

For more information—
Circle 28, inside back cover



Self-Leveling Machinery Mount

This machinery mount consists of an all-steel base unit with leveling screw and leveling plate, combined with a vibration-dampener pad. It is designed in seven models with loading ranges from 800 to 7500 lb per unit; and in four sizes: 4 x 4 in., 6 x 6 in., 8 x 8 in. and 10 x 10 in. One unit is required for each machine leg or mounting point. Felters Co., 210 South St., Boston 11, Mass.

For more information—
Circle 29, inside back cover

Over-Running Clutches

Sealed, double ball-bearing sprag clutches for over-running, indexing and backstopping purposes were designed primarily for indexing applications in which the retention of light oil is essential to long life and accurate indexing. They are also suggested for situations where abrasives are present in the atmosphere, since the seals prevent contaminating particles from entering the clutch.

Series B is recommended for true over-running applications, for low speed service where the inner race over-runs (where both races rotate during some portion of the cycle). It is available in bore diameters from

CONTINUED ON PAGE 242

"SHEAR-SEAL" 4-WAY VALVES, 0 TO 250 P.S.I. AIR

$18.50
List Price*

*$18.50 is the list price for the ¼" port size and $19.50 for the ⅜" less usual quantity discounts.

NO MORE
AIR VALVE
TROUBLES
FROM DIRT OR **CORROSION**

(AND WITHOUT COSTLY FILTERS AND OILERS)

Important Savings	Low initial cost. Need no oilers and filters (time and materials savings).	All components are corrosion resistant.
Low Maintenance	Sealing qualities do not diminish with long, continued use.	Wear compensating "Shear-Seal" design.
Long Service Life	No production delays. Maintenance (rarely needed), without disturbing plumbing.	Lapped metal to metal sealing members.
Not Critical to Dirt	No scoring or binding. (As with spool or poppet designs.)	Flow is through "Shear-Seals." Sealing surfaces remain in constant intimate contact.
No Creeping Cylinders	Leakproof closure. (No internal port to port leakage.)	Maintained through lapping action of each operation.

Ask for bulletin A-5.

Foot operated models with or without spring return to reverse or to center are $24.50 list for the ¼" and $25.50 for the ⅜" valve less quantity discounts.

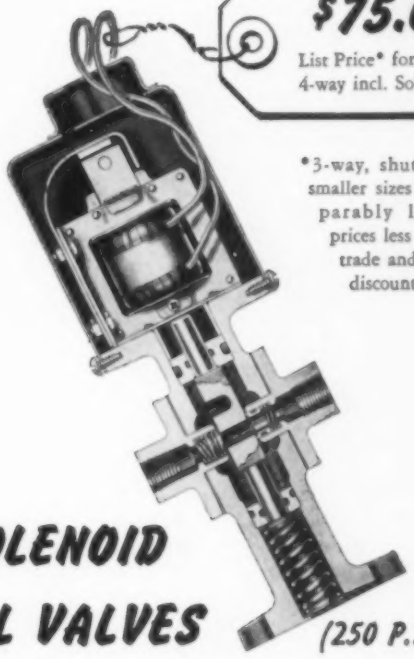
BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

LEAKPROOF (SHEAR-SEAL)

$75.00
List Price* for a ½" 4-way incl. Solenoid

*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

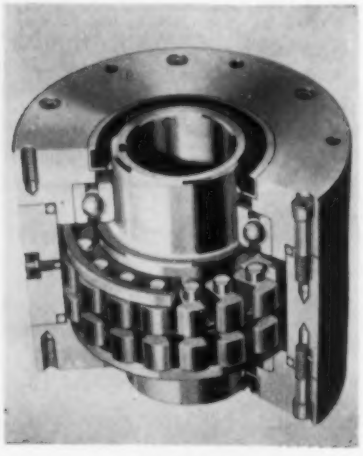


SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members—saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) . . . as versus spool valves which cause overdemand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

BARKSDALE VALVES

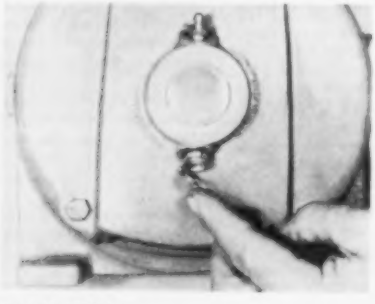
5125 Alcoa Avenue, Los Angeles 58, California
Ask for bulletin 5S-H



2¾ to 5½ in. with torque capacities from 1875 to 11,600 ft-lb.

Series C is intended for indexing and backstopping applications. It is available in bore diameters from 2¾ to 5½ in., with torque capacities from 3160 to 11,600 ft-lb. Formsprag Co., 23601 Hoover Road, Van Dyke, Mich.

For more information—
Circle 30, inside back cover



Relief-Type Lubrication Fitting

A relief-type fitting is now available for use on bearings in motors, machinery, pillow blocks, or any ball or roller bearing housing equipped with conventional relief plugs. The body of the fitting is internally flared to allow free discharge of excess grease.

Although the cap is held tightly in place by spring tension, it snaps open or shut with the flip of a finger. No wrenches or special tools are needed to open the cap, which swivels to any position so that it is easy to reach. Because it is attached to the fitting, the cap cannot be lost or misplaced. Keystone Lubricating Co., 3100 N. 21 St., Philadelphia 32, Penna.

For more information—
Circle 31, inside back cover

Automatic Leveler

This leveler is said to compensate for uneven floors automatically, up to its 3/32 in. adjustment. They are available with ¼-20 machine screws or ¼ in. rivet studs for metal base or gusset mounting, wood screws for wood base mounting, and friction holders for tubular leg mounting. They will support up to 1800 lb. Chicago Sales Engineering, 1 N. La Grange Road, La Grange, Ill.

For more information—
Circle 32, inside back cover

Machine Mounting Pad

Composition of the pad is resin, sisal and granulated cork, fused into an integrated pad. Compounding and processing can be altered to satisfy special requirements. Even after repeated loadings to 1000 psi, the pad is said to recover 99% of original thickness. Clark-Cutler-McDermott Co., Franklin, Mass.

For more information—
Circle 33, inside back cover

Hex Nut Allows for Misalignment

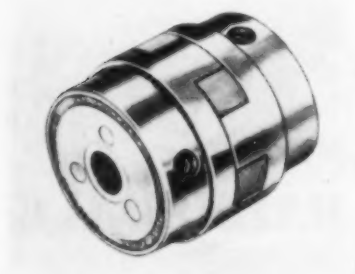
This self-aligning, self-locking hex nut provides for misalignment of up to 8° in any direction between bolt holes and mounting surfaces. Designed with a spherical seat and matching lightweight washer, the fastener is approved for temperatures up to 550 F. Weight is 0.18 lb per 100 pieces in 10-32, and 0.31 lb per 100 in ¼-28. Kaynar Co., 820 E. 16 St., Los Angeles 21, Calif.

For more information—
Circle 34, inside back cover

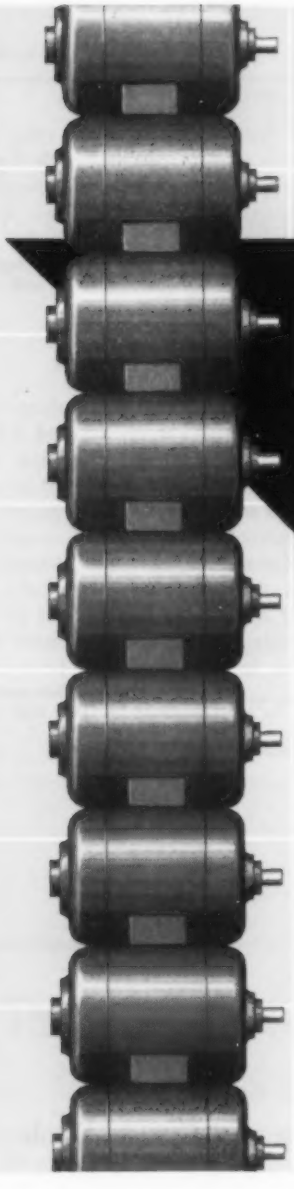
Diecast Flexible Coupling

Installation or removal, assembly or disassembly, can be quickly accomplished, since the coupling consists of two bodies with jaws and a one-piece spider-type cushion. Lubrication is said never to be required.

The cushion spiders out into six load ends which are in sight at all times. On non-reversing loads, only three of the load ends are under compression, while the other three are idling. The cushion can be reversed for added service life. Standard mate-



CONTINUED ON PAGE 244



leading motor manufacturer saves $500 a day...

WITH...

PERMAWICK*

THE REVOLUTIONARY "SELF-WICKING" LUBRICANT

Whether you make motors, blowers, pumps or similar products, you can save 5 cents on every sleeve bearing lubricated with PERMAWICK . . . with little or no change in present bearing design. These extraordinary savings are possible because PERMAWICK replaces *all* felts and felt parts in sleeve bearings . . . completely eliminates all costly hand insertions of these components . . . yet costs less than the material it replaces. Write for brochure.

See PERMAWICK injected by actual production machinery at our booth *536* . . . Design Engineering Show, May 20-23.

*A PATENTED PRODUCT BY . . .

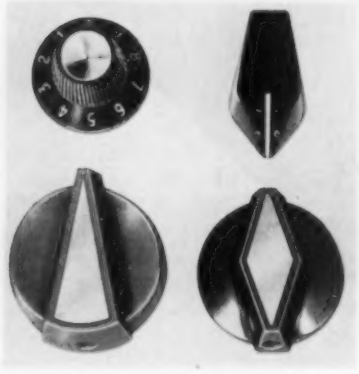
Fluidwick COMPANY

5319 EAST OUTER DRIVE
DETROIT 34, MICHIGAN

rial is oil-resistant, resilient Buna-N compound.

Ratings range from 0.4 hp at 100 rmp to 4.6 hp at 3600 rpm, using standard cushions. Dimensions are 2½ x 2⅛ in. OD. Bores run from ⅜ to 1 in. in increments of ⅛ in., or can be furnished solid. Weight is 1¼ lb. Lovejoy Flexible Coupling Co., 4856 W. Lake St., Chicago 44, Ill.

For more information—
Circle 35, inside back cover



Plastic Knobs

Molded of thermosetting materials, these knobs are available with slotted or socket type set-screws as well as other types of mountings. They are available in various colors and may be equipped with decorative metal inserts.

These knobs have been designed for general commercial use, appliances, radio-electronic equipment, instruments, heating and air-conditioning units. Rogan Brothers, 8003 N. Monticello Ave., Skokie, Ill.

For more information—
Circle 36, inside back cover

Constant Level Oiler

The constant level oiler is said to eliminate variation in drop feeding, since the oil which feeds the sight feed valve is always at the same level. This level is maintained in the base of the reservoir. Its operation is based on the liquid seal principle. When the oil level recedes because of oil consumption, the liquid seal on the spout is temporarily broken.

This allows air from the air intake to enter the oil reservoir, releasing oil until the seal and the proper level are again restored. The constant level insures a steady rate of drop feeding regardless of the amount of oil in the reservoir.

This unit can be supplied with single or multiple sight feed valves for individual flow to each bearing. Up to 24 sight feed valves can be separately adjusted and settings retained by means of a friction screw. Drop feeding of oil to widely separated bearings is controlled and observed from one central point.

The oiler's solenoid valve is usually wired across the line of the driving motor, starting and stopping with the motor providing automatic operation. The solenoid can also be energized by a switch or timer. Shutting off the oil supply with the solenoid valve will immediately stop the drop feeding of the sight feed valves. Oil-Rite Corp., 2382 Waldo Blvd., Manitowoc, Wis.

For more information—
Circle 37, inside back cover

Air Suspension System With Time Delay

This system automatically maintains the most desirable axle-to-chassis height in trucks, buses, trailers, machinery, material handling equipment. Large orifices provide rapid, accurate corrections of changes in height, except for normal suspension motion caused by road irregularities. A time-delay device conserves air by actuating the valves only after a sustained change in height. This time delay is adjustable to the requirements of the load.

A check valve built into the air inlet stops bellows air from flowing back into the supply line in event of supply failure. The exhaust valve also acts as a safety, relieving bellows pressure in excess of 150 psi. Republic Mfg. Co., 15655 Brookpark Road, Cleveland 11, Ohio.

For more information—
Circle 38, inside back cover

Vibration Mountings

Dimensions and load ratings vary from 1.8 to 8.5 in. dia and 0.5 to 50 lb respectively. Vibration and shock performance is different in each model so as to provide the proper environmental protection. To mount the equipment, either clamp fasteners or four pre-spaced mounting holes are used to simplify replacement of the mounted equipment. Robinson Aviation, Inc., Teterboro, N. J.

For more information—
Circle 39, inside back cover

Threaded Control Knob

A hand-machined Lucite knob is available for lathe controls, machine equipment gear controls on automotive, industrial, farm and other equipment. Red, blue, green and amber are the colors offered and the thread size ranges from ⅜ to ⅞ in. Rainbow Plastics, 3232 N. Meeker Ave., El Monte, Calif.

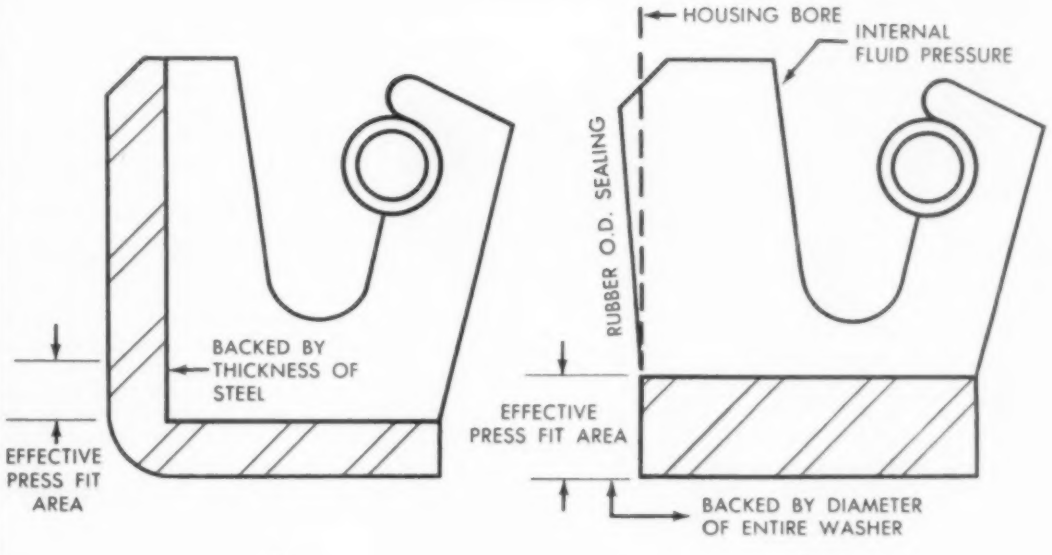
For more information—
Circle 40, inside back cover

Blind Drive Rivet

Designed for installing plywood and composition board, the rivet provides an extra-large, under-head bearing area. This permits higher loading pressures

CONTINUED ON PAGE 246

Which bonded Seal would you select?



That, of course, depends on your specific problem, but IPC custom designs and molds either type

Illustration A shows a typical design for bonded case seals. Note the area designated as "effective press fit". This is a crucial sealing area above the rounded shoulder of the seal and in this type of construction the "press fit" area is not directly in line with the base of the seal, but is backed by the thickness of the case material and the shear area between the O.D. of case and base of seal. This type of seal is easily installed.

However, in illustration B there are other advantages . . . First, note the thickness of the washer with its squared-off area at the base of the seal. Here the "effective press fit" area is in direct line with a large mass of material. The "press fit" is supported by the entire mass of metal in the heavy washer. This type of seal is especially effective when internal fluid pressures are high and can force the rubber out against the bore. They seal more securely . . . over a longer period of time. Real economy here, too!

Both types of IPC bonded seals are far superior to the old combination of a molded rubber member inserted into a rolled metal case.

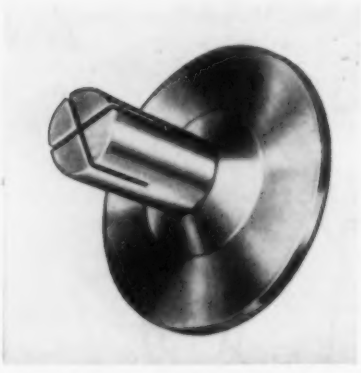
That's a quick look at IPC's thoroughness. Whatever your application, IPC will draw on experience and custom compounding skills to provide you with the best solution. Ask your IPC representative for the facts on IPC leather and synthetic oil seals, packings and precision molded products.

PACKINGS • OIL SEALS IPC PRECISION MOLDING

INTERNATIONAL PACKINGS CORPORATION

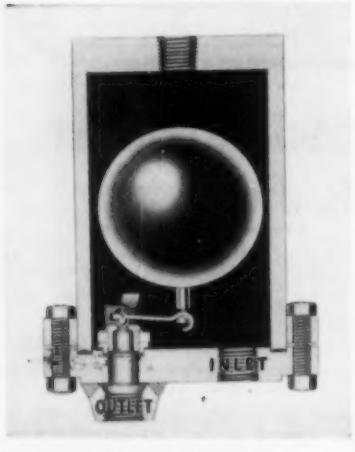
Bristol, New Hampshire

P3



without failure of the board surface. The rivets are available in two head styles, flat and ovaled flat, both heads having a $\frac{3}{8}$ in. dia and a countersunk shoulder. The rivet shaft is $\frac{1}{8}$ in. dia and six lengths accommodate nominal grips from $\frac{1}{16}$ in to $\frac{3}{8}$ in. Rivet bodies are aluminum. The drive pins are stainless or cadmium-plated steel. Southco Div., S. Chester Corp., Lester, Pa.

For more information—
Circle 41, inside back cover



Dual Gravity Float Traps

These traps are designed for interface service to discharge water or heavy liquids and close for light liquids. The discharge valve is actuated by a stainless steel ball float, weighted to sink in a light liquid and float in a heavy liquid.

These traps are produced in two series; semi-steel for low temperatures to 300 psi; and, fabricated steel for low temperatures to 1000 psi. Clark Mfg. Co., 1830 E. 38 St., Cleveland 14, Ohio.

For more information—
Circle 42, inside back cover

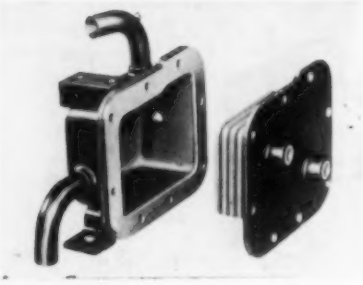


Plate-type Engine Oil Cooler

An engine oil cooler varies from two to eight-plate arrangements, and is said to be designed for use on or in any engine requiring lubricant cooling. Current applications extend to 400 btu per min. It may be applied to any type of oil cooling, such as in transmissions, torque converters and hydraulic presses.

The water side of this heat exchanger may be readily cleaned. When cleaning or replacement is indicated, the multiple-plate core assembly can be removed from the housing without disturbing the water connections. Dept. LM-16, Long Mfg. Div., Borg-Warner Corp., 12501 Dequindre St., Detroit 12, Mich.

For more information—
Circle 43, inside back cover

Graphite Rupture Disks

Impervious graphite rupture disks are furnished for operating temperatures up to 650 F. An insulating and spacer ring hold a heat-insulating material on the vessel side of the pressure membrane of the disc. This insulating arrangement does not affect the burst characteristics of the disc in any way, it is claimed.

These discs are accurate to ±5% of rated burst, and are available for use at 75% of rated burst, are unaffected by practically all corrosives, and provide almost 100% clean rupture to allow maximum opening for safe escape of excess pressure.

The rupture discs are available in standard diameters from 2 to 12 in. for pressures from full vacuum to 100 psi. On order, discs are available to 24 in. dia at burst ratings to 250 psi. They are suitable for use with gas or liquid and are designed for mounting in standard ASA flanges. Falls Industries, Inc., Aurora Road, Solon, Ohio.

For more information—
Circle 44, inside back cover

ELECTRICAL POWER, CONTROL

Printed Circuit Layout Tape

Pre-cut shapes and terminal strips made from photographic tape have a snow-white adhesive side and a jet-black, non-reflective top side. Circuits are drawn with shapes on both sides of cloth or film.

Layout is placed on a white surface for photographic reproduction. White shapes and strips on the reverse side of the layout do not register. After exposure, the second side of the layout is photographed. Shapes are available in graduated sizes of $\frac{1}{16}$ in. and fractional increments. Angles, curves, ellipses, circles can be made quickly. Elbows, tear-drops, fillets and circles are available in a wide range of sizes. W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.

For more information—
Circle 45, inside back cover

Telescoping, Oiltight Wiring Fitting

Telescoping fittings which are oiltight are available in 2½ x 2½ in., 4 x 4 in., and 6 x 6 in. gasketed wir-

CONTINUED ON PAGE 248

Using

DU PONT ELASTOMERS

NEOPRENE · HYPALON®

in Design

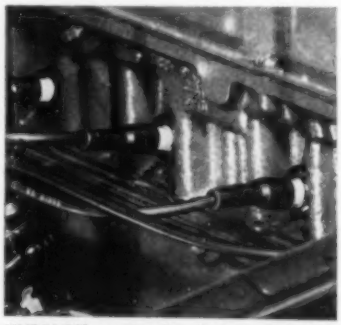
Molded spark-plug boots of HYPALON® withstand ozone and heat (270°F.)

Several years ago a leading car manufacturer set out to find a new rubber material for its spark-plug boots. New designs had increased engine horsepower but at the same time reduced engine space, thus increasing the temperature under the hood. Existing boots couldn't take the punishment of temperatures averaging 270°F. with occasional peaks of 340°F., or the increased ozone concentration caused by reduced space under the hood.

After testing several resilient materials, they decided on Du Pont HYPALON synthetic rubber. HYPALON has exceptional resistance to deterioration at high temperatures and it is virtually ozone-proof. The problem was solved. HYPALON has been specified for the spark-plug boots on this manufacturer's new V-8 and six-cylinder engines.

HYPALON also offers outstanding resistance to weather and oxidizing chemicals. And it can be compounded in an unlimited range of sunlight-stable colors.

Why not investigate the possibilities of using HYPALON in your designs? We'll be glad to send you complete property data and application information. If you have a specific problem, please let us know.



HYPALON spark-plug boots resist high ozone concentrations and temperatures averaging 270°F., in the engine of one of today's leading cars.

Why Remington uses NEOPRENE on its new model stud driver

Powerful and fast, the new Remington "MIGHTY-MITE" stud driver uses a 22-caliber cartridge to drive ¼" studs in steel or concrete without pre-drilling.

The "MIGHTY-MITE'S" barrel must be twisted and held firmly against the work to expose the firing pin. Neoprene traction grip stands up to grease, oil and perspiration.

Neoprene resists grease, oil and perspiration, assures a firm tool grip

Small contractors and "do-it-yourselfers" are finding the new Remington "MIGHTY-MITE" a handy tool for driving ¼" studs into steel or concrete. Just a hammer tap fires the 22 caliber cartridge, which drives the stud, anchoring wood or steel fixtures in seconds—without pre-drilling.

Design features of Remington's "MIGHTY-MITE" are simplicity and safety. The barrel of the tool must be twisted, then thrust down and held firmly against the work to expose the firing pin. Neoprene was selected for the barrel traction grip because of its resistance to the effects of grease, oil and perspiration. A green neoprene compound was selected because it enhanced the appearance of the finished product.

This is just one application where neoprene has proved its effectiveness. If you need a resilient material with exceptional resistance to oils, greases, solvents, chemicals, abrasion and flex cracking, it will pay you to investigate neoprene. We'll be glad to send you further information—data on properties and proven applications. If you have a specific problem, please let us know.

DU PONT

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

☐ I am particularly interested in _____

☐ Please add my name to the mailing list for your free publication, the ELASTOMERS NOTEBOOK.

Name _____

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Department PE-5
Wilmington 98, Delaware

Firm _____

Address _____

City _____ State _____

ing ducts, for use on machinery where oil and dust are problems. When incorporated into a wiring system, the telescoping section permits adjustment to any desired length.

After adjusting the unit to the proper length, the O-ring gasket and the two sliding retainer plates are bolted to the end flange of the straight section, forming an oiltight junction. The telescoping section for each of the three sizes is 15½ in. long, and permits adjusting the length of an assembly between 1½ and 13½ in. It is made of 14 gage steel, except for the welded end flange and the two sliding sleeves, which are 11 gage. Hoffman Engineering Corp., Anoka, Minn.

For more information—
Circle 46, inside back cover

Printed Circuit Boards of Metallized Glass

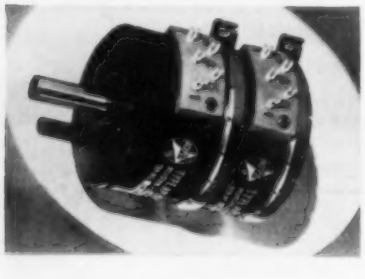
Metallized glass printed circuit boards for high temperature applications under high humidity conditions can withstand a continuous operating temperature of 500 C. This board is said to be capable of extremely small, close-tolerance holes with close center-to-center distances.

These printed circuit boards are now available in thicknesses (after etching) of 0.050, 0.050, 0.063, 0.075, 0.115, 0.140, 0.170 and 0.235 in. Maximum size available is 12 x 18 in. Corning Glass Works, Corning, N. Y.

For more information—
Circle 47, inside back cover

Non-linear Potentiometers

Potentiometers for sine-cosine functions are available in AIA sizes 30 and 20, with tolerances of ±0.5% peak to peak and ±1% peak to peak respectively. Standard square-law units are available in AIA sizes 30 and 20, with tolerances of ±0.25% independent conformity and ±0.75% independent conformity respectively. Ace Electronics Associates, Inc., 103 Dover St., Somerville 44, Mass.



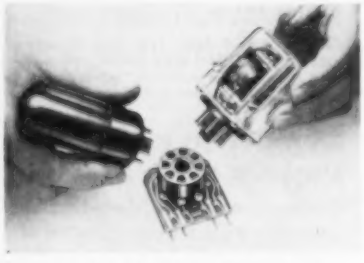
For more information—
Circle 48, inside back cover

Miniature Time Delay Relay

Encased in metal, this relay is supplied already compensated for normally encountered temperatures. Available in 6.3 v, 26.5 v, and 120 v heaters, approximately 2 w. Contacts are available in either normally open or normally closed arrangements.

This relay will carry a 3-amp load, with a timing range of 10 to 90 sec. The seated height of the seven-pin base unit is 1⅞ in. and is all metal. O.K. Electronics Corp., 7 Hunt Pl., Nutley 10, N. J.

For more information—
Circle 49, inside back cover



Right-Angle Octal Socket

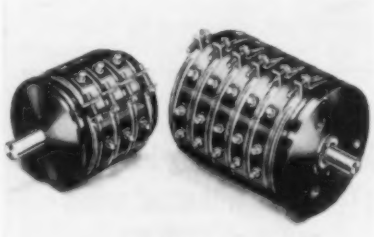
Suitable for GT type octal tubes and octal base relays and coils, the socket is mounted on a laminate base with a printed circuit supplying the circuitry to the socket and the component. The socket is suitable for use on such products or components where UL-approval is required.

Base material is 1/16 in. XXXP phenolic (NEMA grade) and the copper pattern is 0.0027 in. on two sides, offering a current-carrying capacity of 15 amp per connection. Cleveland Metal Specialties Co., 1783 E. 21 St., Cleveland 14, Ohio.

For more information—
Circle 50, inside back cover

Potentiometer Has Unlimited Phasing

Designated the RL-270B, this potentiometer requires ⅜ in. depth per section. It is rated for continuous service up to 150 C. Number of taps is limited only by physical spacing.



Three styles of mounting are possible, servo, bushing and three-hole bushing. Gamewell Co., Newton Upper Falls 64, Mass.

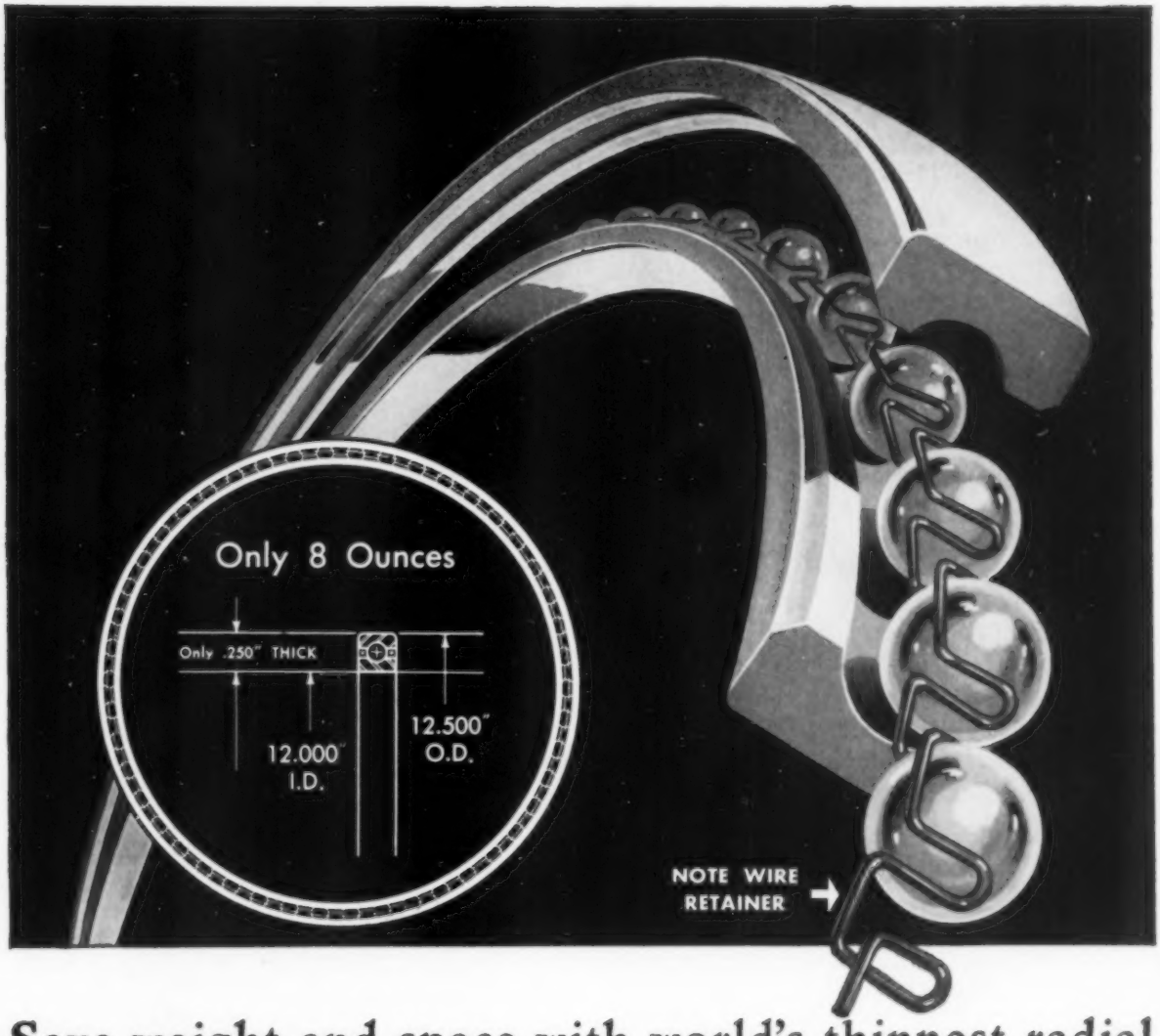
For more information—
Circle 51, inside back cover

D-c Power Supplies

A heavy duty, regulated d-c power supply provides forced air cooling on the 2 and 3 amp models. A time-delay relay, associated with a holding relay, provides initial warmup time before the application of plate voltages. The power supply is automatically protected against line failure.

There are 84 models in the series, in 1, 2 and 3 amp current ranges, with voltages beginning at 25 to 75 v and rising in 50 v steps to a range of 350-400 v. Standard (0.5%) or precision (0.1%) regulation may be specified. These power supplies are electronically regulated; transient response is 1.0 millisec in standard models, 0.1 millisec in precision models. Ripple for standard models is 5 milliv, for

CONTINUED ON PAGE 250



Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

K-561

All types of ball and roller bearings — 4" to 120" outside diameter . . .
Taper Roller • Rollet Thrust • Roller Radial • Bi-Angular Roller • Needle Roller • Ball Radial • Ball Thrust Bearings.

precision models, 2 milliv. Universal Electronics Co., 1720–22 St., Santa Monica, Calif.

For more information—
Circle 52, inside back cover

Flexible Shaft Terminals For Valve Control

These terminals are for use as valve couplings, as intermediate connections to go through floors, and for remote operating stations. Models can be obtained for connecting to ¼, ⅜, 1, 1¼ or 1⅜ in. flexible shafting. The valve couplings are designed to fasten to the valve handwheel spokes by U-bolts. Any of these valve couplings can be obtained either with or without a quick disconnect attachment.

After the couplings are fastened to the handwheels the flexible shafts are fastened to the couplings by simply pinning the flexible shaft fitting to the spindle on the coupling. Stow Mfg. Co., 426 Shear St., Binghamton, N. Y.

For more information—
Circle 53, inside back cover

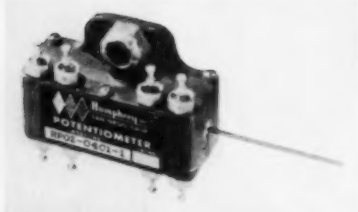
Contact Screw

The screw is essentially a fine silver or silver alloy core, silver brazed to a high-strength metal alloy shell, which is threaded. The precious metal core is continuously bonded to the threaded shell.

It is reported that no oxides can develop between the precious metal and the outer shell, assuring positive

and permanent electrical conductivity between the precious metal and the outer shell. The screws are available in all sizes on special order. George Ulanet Co., 413 Market St., Newark, N. J.

For more information—
Circle 54, inside back cover



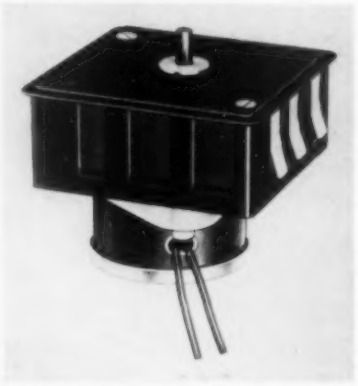
Subminiature Rectilinear Potentiometer

Designed for hydraulic valve or other short-stroke applications, this potentiometer is suitable for both d-c and a-c and has been qualified for severe environmental conditions. Glass-seal terminals, stainless steel push-rod and 100% bonded construction are provided. The instrument weighs 1 oz and is 1.40 x 0.56 x 1.13 in. wide. The resistance of both elements is 1000 ohm, ±5%, linearity 0.75% and resolution 0.002. Power dissipation of each element is ½ w. Electrical travel is 0.050 and mechanical travel 0.75. Humphrey Inc., 2805 Canon St., San Diego 6, Calif.

For more information—
Circle 55, inside back cover

Interval Timer

A molded case houses one or two single-pole, double-throw or single-pole, single-throw open blade switches,



rated at 30 amp, 115 v a-c resistive and ½ hp at 115 v a-c. The permanent magnet synchronous motor drives cams which actuate the 30 amp switches at full-scale intervals, ranging in duration from 45 sec to 6 days. These timers are for all standard voltages, 60 and 50 cps, and a wide selection of special voltages. Cramer Controls Corp., Centerbrook, Conn.

For more information—
Circle 56, inside back cover

Environment-Resistant Connectors

These plugs and receptacles are said to be impervious to water, moisture, oil, gas, dust, pressure, vibration and shock. The connectors meet and ex-

CONTINUED ON PAGE 252

A Man Nobody Wants

This one is always on the move but never on the go. His movement is aided by lead, well placed immediately above the seat of the swing. On the wall of his office is a large sampler lovingly embroidered: "Home, Sweet Home." That is his personal creed and he keeps trying to get the whole company to adopt it.

As his orbit is unchanging, he will never find Rogers. But Rogers will not brood over his continued absence.

For Rogers serves engineers – those men who swoop purposefully across the heavens, searching the stars for new points of reference. An ever-growing body of such men is finding Rogers a dependable ray of light in terms of engineered materials – special formulations as different and daring as the ideas that engendered them.

Samples – and both down-to-earth and up-in-the-clouds literature – will be sent to any engineer. Please let us have your name and address.

ROGERS
CORPORATION
ROGERS, CONNECTICUT

DUROIDS—for Gaskets, Filters, Electronic Devices, Thermal Insulation, etc. **ELECTRICAL INSULATION**—for Motors, Transformers, Generators, etc.
SHOE MATERIALS—for Counters, Midsoles, Liners, etc. **PLASTICS**—Special Purpose Molding Compounds and Laminates **RUBBER**—for Floats, Grommets, Gaskets, Bearing Seals, etc.
FABRICATING—Including Converting, Combining, Coating, Embossing, and Molding **DEVELOPMENT**—Research and Engineering of Unique Materials, Parts and Products

Precise, yet rugged, too

Like Old Reliable here, MAC valves are proved performers. They're designed for dependability . . . precision built to operate *exactly*—cycle after cycle. That's because we demand much more from our valves than just ordinary duty. MAC spools, for instance, are engineered to withstand at least 75 times actual use load. MAC springs are "shot-peened"—a process that lengthens life by more than 1000% and virtually eliminates spring failure.

So it goes—*right down through the assembly line.* We build in the important "extras" that make the difference. And that's why you can expect more from a MAC valve—in performance, dependability and long life. Contact a representative listed at right. His know-how can help you with any air valve application.

MECHANICAL AIR CONTROLS, INC.
10030 Capital, Oak Park, Detroit 37, Michigan

MAC

PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., LOrain 4-2521

COLORADO (and NEW MEXICO, UTAH, WYOMING)
DENVER 16—Blair Engineering Co., 4100 Grape St., FLorida 5-7142

FLORIDA
MIAMI SPRINGS—Aero Hardware & Supply Co., 4301 Northwest 36th St., TUxedo 8-2414

ILLINOIS
CHICAGO 43—Mike C. Modrich Co., 10918 South Western Ave., HIlltop 5-3640

INDIANA
FORT WAYNE 3—Neff Engineering Co., P.O. Box 2001, Station A, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 20—Neff Engineering Co., P.O. Box 7361, 42nd St. Station, CLifford 5-5418
SOUTH BEND—Dick Futter, 103 South Varsity Dr., CEntral 2-3800

MASSACHUSETTS (and New England)
BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440

MICHIGAN
BAY CITY—Fred Kober, 506 Chilson St., TWinbrook 2-2629
FLINT—Kober Sales Engineering Co., 1115 Root St., CEdar 2-7165
WESTERN MICHIGAN—Everett Adams, 17212 Sharon Road, Chesaning, Michigan, Chesaning 383-J-1

MINNESOTA
MINNEAPOLIS 4—Air Engineering & Supply Co., 2445 Nicollet Ave., FEderal 9-5579
ST. PAUL 14—W. H. Schulz Co., 2438 Franklin Ave., MIdway 4-2791

MISSOURI
ST. LOUIS COUNTY—Oscar E. Jost Co., P. O. Box 6, St. Ann, HArrison 8-4488

NEW YORK
BUFFALO 25—C. H. Tepas Co., 200 Washington Hwy., CIrcle 3210

OHIO
CINCINNATI—The R. W. Nichols Co., Fidelity Federal Savings Bldg., 2087-9 Sherman Ave., Norwood, ELmhurst 1-2440
DAYTON—The R. W. Nichols Co., 407 Realty Bldg., MIchigan 4724
OLMSTED FALLS—The R. W. Nichols Co., P. O. Box 6, ADams 5-3366
TOLEDO 4—The R. W. Nichols Co., 510 Manhattan Building, CHerry 1-1447

OREGON
PORTLAND—The Rucker Co., 911 N. W. Hoyt St., CApitol 3-0205

PENNSYLVANIA
PITTSBURGH 22—The R. W. Nichols Co., 101 Investment Bldg., ATlantic 1-6050

TEXAS
DALLAS 19—Womack Machine Supply Co., Shea Rd. at 7150 Harry Hines, FLeetwood 7-3871

WASHINGTON
SEATTLE—The Rucker Co., 1000 4th Ave., South, MAin 2783

WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 N. Pt. Washington Rd., EDgewood 2-1579

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN
MAC

ceed performance requirements of Class A, B, C, and E of military specifications MIL-C5015B as well as NEMA requirements for power, lighting, control and coaxial circuits. Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.

For more information—
Circle 57, inside back cover

Silicone Rubber Heating Tapes

The tapes are fabricated of stranded resistance wires, insulated with braided glass fiber yarns and knitted into flat tapes, which are embedded in silicone rubber. Temperature limit is approximately 900 F. The tapes are available in widths of ¼ to 4 in., in ⅛ in. increments and unlimited lengths. Resistance may be varied from 0.3 to 70 ohm per ft of wire. They may be embedded in conventional resins or laminated with glass fiber fabric. Briscoe Mfg. Co., 1055 Gibbard Ave., Columbus 3, Ohio.

For more information—
Circle 58, inside back cover

High-Temperature Electrical Insulation

An organic insulation said to approach the heat-resistant characteristics of Class H silicone materials and having good solvent resistance is made of flexible, straight-weave, continuous-filament glass fabric, coated with a modified silicone resin. Dielectric strength as measured by the short-time, ¼-in. dia electrode method, is 1250 v per mil at 1000 hr, 200 C.

The material weighs approximately ½ lb per sq yd, is 0.007 in. thick and has a tensile strength of 164 lb per in. of width. Westinghouse Electric Corp., Micarta Div., Trafford, Pa.

For more information—
Circle 59, inside back cover

Illuminated Oiltight Pushbutton

The pushbutton has transformers rated for either 110, 220 or 440 v, 60 cps. The unit may be obtained in either guarded or unguarded form. Color caps, which provide all-angle visibility, are available in six colors:

(Continued on page 254)

YOU CAN SAVE TIME, TROUBLE AND COSTS with

Formed Tubes...

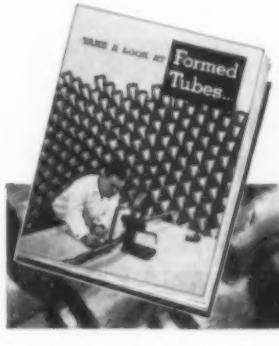
★ **Save Time**
We have a huge stock of dies and, when needed, tooling's fast. We also avoid delays by making our own electrically welded steel tubing, sizes from ⅝" to 3" OD.

★ **Save Trouble**
Long, active experience with all tube forming processes and high standards of quality control make sure your orders will be completed *right.*

★ **Save Costs**
It's routine for formed tubes parts to deliver top performance, save weight, cut costs. Steel, copper, brass, aluminum or stainless tubing fabricated in ⅜" OD to 6" OD sizes; from 20 to 11 ga. metal.

Formed Tubes, Inc.
507 Prairie, Sturgis, Michigan

Write for FREE Booklet



You can have all the advantages of

GROUND TOOTH ACCURACIES AT NO GREATER COST

—if you are now using case-hardened gears, starting at about 3″ dia., in quantities of 12 to 25 or more of a kind, depending on size.

It's a Fact! Sier-Bath can supply ground tooth gears to the one best design for each application, with defined tolerances—dimensionally accurate, distortion-free, dependably uniform and with fine finish . . . at prices that make it uneconomical to risk the noise, shock, overloading and premature failure of less accurate, unground gears.

FLASH!

No other gear company can now give you
PRECISION CROWN-GROUND SPUR and HELICAL GEARS
to 12″ diameter, 4 pitch

ADVANTAGES: In spite of great overloads and misalignment, or deflection due to overloading, Sier-Bath crown-ground gears retain centralized tooth loading for far greater strength, opening new opportunities for accomplishment in your machines. Investigate!

Send us specs and prints on your next gear requirements for quotation. Let us demonstrate how Sier-Bath's Precision Gear Clinic—high-speed gear producing equipment—most modern techniques—and skilled gear technicians can bring you better gears at no greater cost.

Sier-Bath PRECISION GEARS

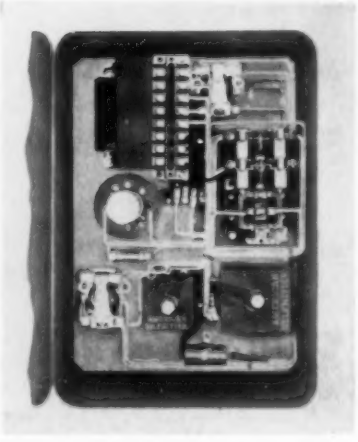
All kinds of gears—all materials
Made—cut—shaved—ground tooth
42″ maximum diameter
12 or more of a kind, depending on size.

Sier-Bath **GEAR & PUMP CO., Inc.**
9238 HUDSON BOULEVARD NORTH BERGEN, N. J.
Founded 1905 Members A.G.M.A.

Also manufacturers of Rotary Pumps and Flexible Gear Couplings

red, green, amber, white, blue, clear. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 60, inside back cover



Electric Motor Brake

A brake for use on any a-c motor from ¼ to 250 hp and up is suggested by the manufacturer for industrial applications where fast, frequent and uniform stops are required. It can be supplied for any voltages up to 600 v, either 60, 50 or 25 cps. No connection of any kind is made to the motor itself. It is applied to the standard starter of the motor.

Braking torque can be adjusted over a wide range to meet the application's requirements without the necessity of ordering a special type. It can be applied to any motor starter at any time. It is far safer than plugging and can

(Continued on page 258)

CUT

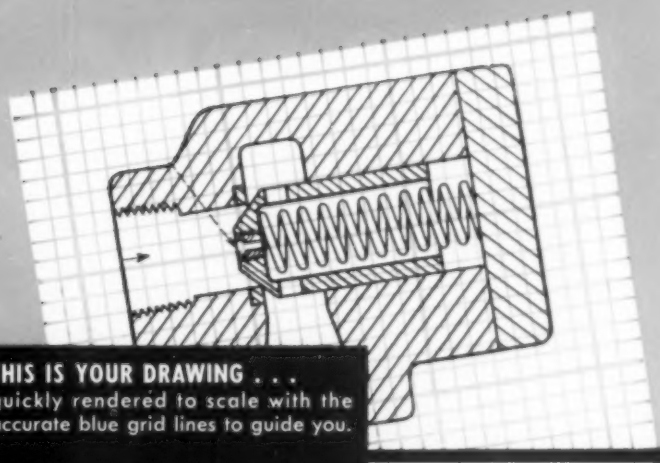
YOUR DRAFTING TIME AND COSTS WITH CLEARPRINT "FADE-OUT" PAPER

Leading engineers and designers report that Clearprint Fade-Out Paper speeds up their drafting 10 to 15% . . . cuts their costs proportionately. And Fade-Out Paper gives them prints which are sharper and easier to read, because grid lines do not reproduce.

Clearprint's perfect working surface invites pencil and pen — lines are sharp and clean. It withstands repeated erasures, too, without the slightest ghosting.

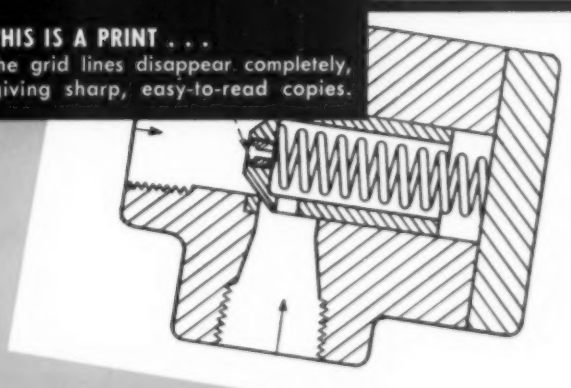
See how Clearprint Fade-Out Paper can solve *your* drafting problems. Order a trial roll now, and apply it to your various drawing needs.

Available with grids ruled 4x4, 5x5, 8x8 and 10x10 lines to the inch.



THIS IS YOUR DRAWING . . .
quickly rendered to scale with the accurate blue grid lines to guide you.

THIS IS A PRINT . . .
the grid lines disappear completely, giving sharp, easy-to-read copies.



. . . for drawings of any desired size (in 24", 30", 36", 42" widths)

. . . the sizes you need for ready use (42" wide by any length)

. . . for fast sketches and calculations

Printed on CLEARPRINT — America's Finest Technical Paper 6

CLEARPRINT®

"FADE-OUT" PAPER

THERE IS NO SUBSTITUTE
Demand Watermarked Clearprint

SEEING is BELIEVING!

Ask your dealer for samples, or send coupon

CLEARPRINT PAPER CO. PE
1482 - 67th Street, Emeryville, Calif.

☐ Please send me sample Clearprint "Fade-Out" sheets, with prices.
☐ Send me Clearprint samples, with prices, for the following uses:

_____

_____

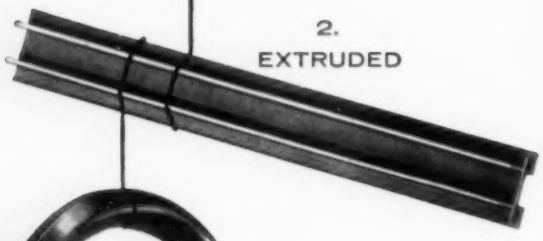
☐ Have your representative call at my office.

Name _____
Firm _____
Address _____
City _____ Zone _____ State _____

ACADIA

MEETS YOUR SYNTHETIC RUBBER NEEDS

BEST OUT OF 3 WAYS!



And when there's another way to form synthetic rubber, you can be sure it will be available from Acadia!

Right now Acadia is precisely meeting all manner of rubber specifications. Very often Acadia helps users to find a better, less costly way.

For in addition to the complete choice of shape, size or method, Acadia offers its wide experience in developing special rubber properties. Here you get exactly the characteristics you want—*strength, compression-deflection, resistance to oil, age or what have you.* Here, too, is the remarkable Acadia SILICONE rubber that stays resilient at 100° *below zero,* or 500° above. It's available molded or extruded for gaskets, seals, "O" rings, washers, sheets, cut-parts and packings.

Would you like further information about Acadia synthetics for *your* product? A letter or postcard will bring an Acadia representative at your convenience.

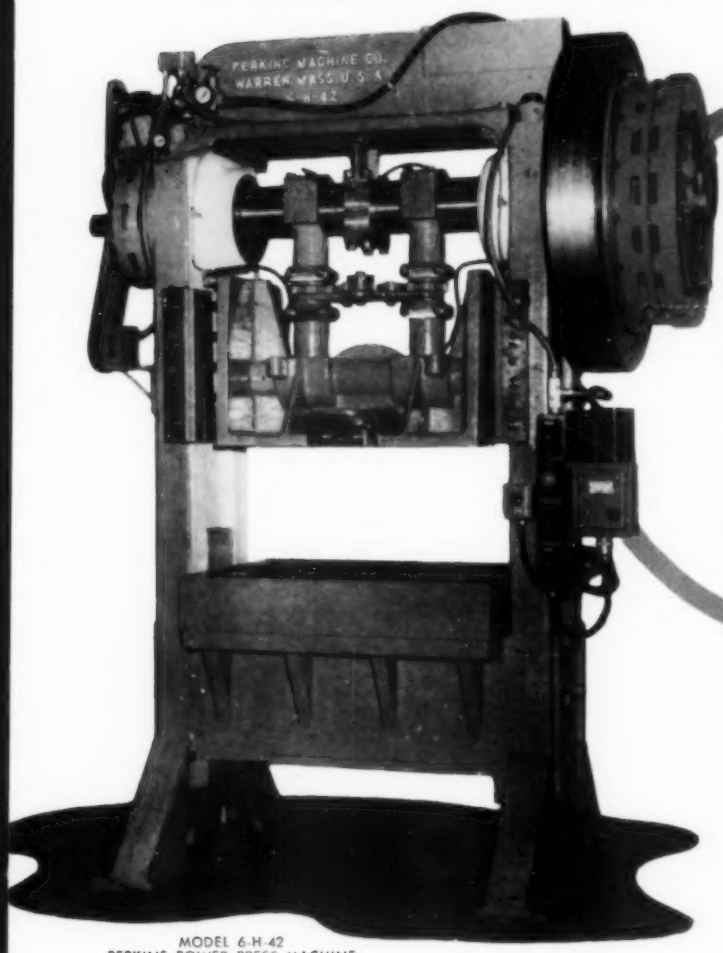
ACADIA *Synthetic* PRODUCTS

DIVISION OF WESTERN FELT WORKS
4021-4139 West Ogden Avenue, Chicago 23, Illinois
Branch Offices in Principal Cities

MANUFACTURERS AND CUTTERS OF WOOL FELT

Faster Operations with WICHITA Air-Tube Clutches!

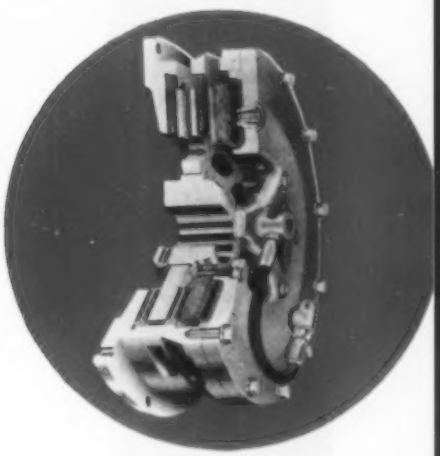
"WITH WICHITA, OUR PRESSES OPERATE AT HIGHER SPEEDS!"



MODEL 6-H-42
PERKINS POWER PRESS MACHINE

Perkins Machine Company of Warren, Mass., Now Obtains Higher Rates of Speed on Larger Machines.

Operations have been materially speeded up on presses built by the Perkins Machine Company due to the amazingly fast engagement and disengagement of WICHITA Low Inertia Air-Tube Clutches and Brakes. Increased speed comes from minimum air volume in the tube, easier flexing of tube, Low Inertia design, and the multiple Quick Release Valves on WICHITA Clutches. Faster operations assure increased production!



OTHER OUTSTANDING FEATURES

- POSITIVELY VENTILATED FOR HIGH HEAT DISSIPATION
- SOFT, SMOOTH ENGAGEMENT
- EFFICIENCY ENGINEERED
- EXTREMELY LONG LIFE
- SIMPLE DESIGN
- NO LUBRICATION
- NO ADJUSTMENTS
- NO BACKLASH
- LOW INERTIA DESIGN

Consult Your Nearest Wichita Engineer for Complete and Detailed Information

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

WICHITA DISTRIBUTORS

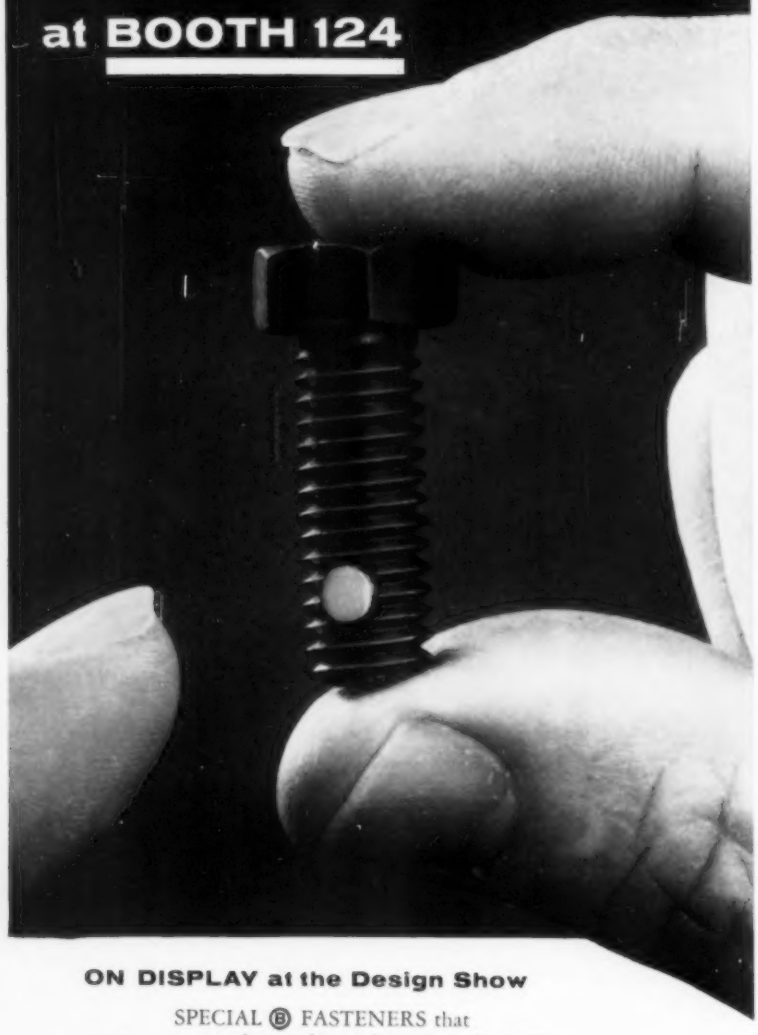
Brehm-Lohner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co. (Main Office), Avon, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, New York
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Andrew T. Lobel, Denver, Colorado
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Okla.
Dominion Power Press Equipment Ltd.
Burlington, Ontario, Canada
Industrial Air Controls Co., Fort Worth, Texas
Allied Transmission Equipment Co.,
Kansas City 8, Missouri

Be sure to see... B SPECIAL FASTENERS

featuring

LOCKING BOLT DEMONSTRATIONS

at BOOTH 124



ON DISPLAY at the Design Show

SPECIAL Ⓑ FASTENERS that speed assembly, reduce costs, improve product design. Ⓑ LOCKING BOLTS that stay wrench-tight, won't vibrate loose, provide leakproof seals for air, gas, and liquids.

Fasteners by Buffalo Bolt can help increase the strength and reputation of YOUR products ...be sure to see them at BOOTH 124.

● *If you miss the show... WRITE for Special Fasteners Brochure.*

BUFFALO BOLT COMPANY

DIVISION OF BUFFALO-ECLIPSE CORPORATION

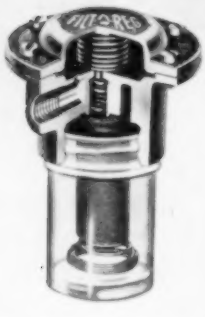
NORTH TONAWANDA, N. Y.

Making both Fasteners and Friends for 100 years

be applied to a single-phase as well as three-phase motor with slight modification in its internal connection.

The brake is housed in standard metal enclosures for mounting adjacent to the motor. Oil mist or dust will not affect operation. It can be supplied with an electrical lock as optional equipment, which is released only when the operator presses the starter button. Magnetic starters are supplied as optional equipment if needed. Selenibrake Div., American Rectifier Corp., 95 Lafayette St., New York 13, N. Y.

For more information—
Circle 61, inside back cover



Fuel Pressure Regulators

A combination fuel pressure regulator and fuel filter unit and a straight fuel pressure regulator are made in three fuel pressure capacities. The regulator mechanism is the same, but each model is factory set for a constant maximum psi.

The 2 psi model is for general use on most gasoline engines having fuel pressure systems. A 3 psi unit is recommended for use on high horsepower passenger car engines with two and four-barrel carburetors. A ¾ psi model is for smaller engines with gravity fuel feed. Alondra Sales, Inc., 959 Crenshaw Blvd., Los Angeles 19, Calif.

For more information—
Circle 62, inside back cover

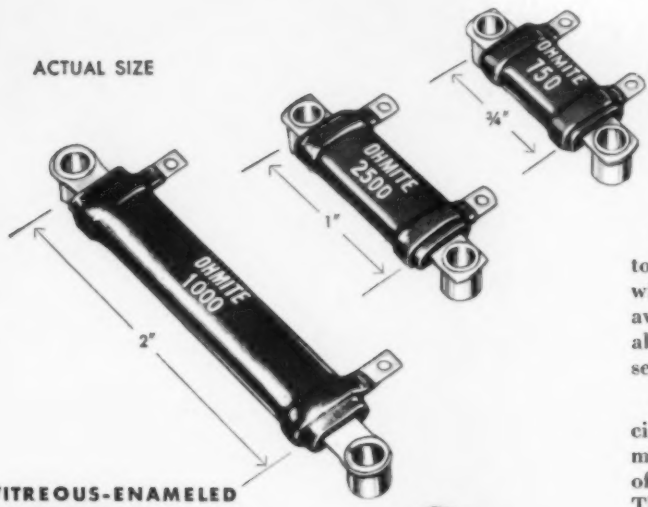
Bi-directional Stepping Motor

The output shaft is locked into position after each actuation and cannot be rotated by external forces. Angular accuracy is within $\pm\frac{1}{2}°$. Although it is ordinarily manufactured to move

(Continued on page 261)

...pack higher wattage into less space with NEW MINIATURE OHMITE® THIN-TYPE power resistors

ACTUAL SIZE



VITREOUS-ENAMELED COVERING holds winding rigidly in place . . . protects winding from damage.

UNIFORM WINDING prevents "hot spots" and resultant failures.

STRONG, CERAMIC CORE provides a solid base for winding. Core unaffected by cold, heat, or high humidity.

INTEGRAL MOUNTING BRACKETS distribute heat more evenly throughout resistor and conduct heat away.

The new Ohmite *miniature* thin-type power resistors are now available in three wattage sizes in a wide range of resistance values; two wattage sizes are available from stock; also three wattage sizes available from stock in the standard thin-type resistor . . . see (*) table below.

Designed especially for use in modern electronic circuitry where space is at a premium, these new miniature units have all the timeproven superiority of standard Ohmite vitreous-enameled resistors. They are only 1/8" thick and 3/8" wide, and range in length from 3/4" to 2".

Because of their compact design, the new Ohmite *miniature* thin-type resistors pack higher wattage into less space. The stacking bracket allows mounting close to the surface and a hollow stud provides for convenient stacking of two or more units. The miniature thin-type rises only 11/32" above the mounting surface; stack mounted, four units are less than 1 1/8" in height. Shown in photograph are: 1 Standard Thin-Type Resistors with Unit Brackets; 2 Standard Thin-Type Resistor with Stacking Brackets; 3 Miniature Thin-Type Resistors.

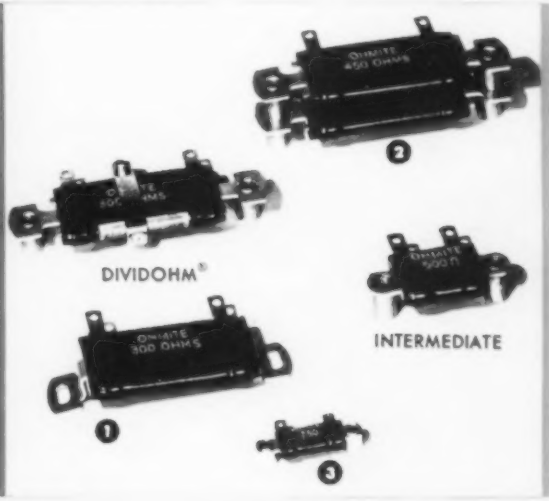
Write on company letterhead for Bulletin 138-B.

Watt Rating	Length of Core	Width of Core
MINIATURE THIN-TYPE RESISTORS		
* 10	3/4"	3/8"
15	1"	3/8"
* 20	2"	3/8"
INTERMEDIATE THIN-TYPE RESISTORS		
20	1"	13/16"
30	1 1/2"	13/16"
STANDARD THIN-TYPE RESISTORS		
* 30	1 1/4"	1"
* 40	2"	1"
* 55	3 1/2"	1"
65	4 3/4"	1"
75	6"	1"

Now available from stock . . .

2 miniature sizes: 10 and 20 watts

3 standard sizes: 30, 40, and 55 watts



WATTAGE RATINGS ARE BASED ON THE RESISTOR MOUNTED ON A HORIZONTAL STEEL PANEL .040" THICK BY 10" SQUARE. RATINGS SHOULD BE REDUCED APPROXIMATELY 15% FOR NONMETALLIC MOUNTING SURFACE.

BE RIGHT WITH OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY • 3611 Howard Street, Skokie, Illinois

Ohmite maintains the world's largest stock of power-type resistance products—high-quality rheostats, wire-wound resistors, and tap switches in a factory stock of several million in a complete range of sizes, values, and types.

When you need these resistance components in a hurry, Ohmite can make fast delivery in reasonable quantities to meet your immediate requirements.

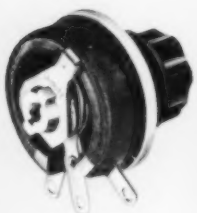
Furthermore, by tailoring your specifications to these stock items, you can always get speedy delivery that will help you keep experimental and pilot production operations on a smooth-running schedule.

To assist engineers and purchasing agents in making their selection from this huge stock, Ohmite *Stock Catalog No. 28* contains complete, up-to-date information on all Ohmite stock items. Resistance values, ratings, specifications, and other helpful information are included.

WORLD'S LARGEST STOCK

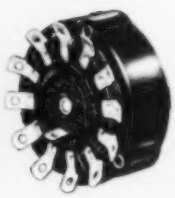
WIRE-WOUND RESISTORS

Fixed and "Dividohm" adjustable wire-wound types, 5 to 200 watts. Also composition type.



RHEOSTATS

Ten stock sizes—25 to 1000 watts. All-ceramic and metal.



TAP SWITCHES

Rotary type. Five sizes from 10 to 100 amps, with from 2—12 taps.

WRITE FOR STOCK CATALOG

BE RIGHT WITH

OHMITE®

RHEOSTATS **RESISTORS** **RELAYS**

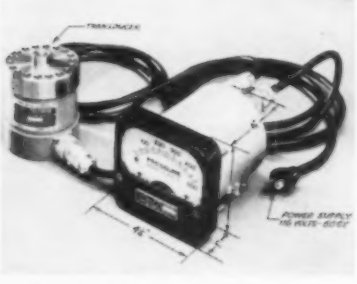
TAP SWITCHES **TANTALUM CAPACITORS**

OHMITE MANUFACTURING COMPANY
3611 Howard Street, Skokie, Illinois

bi-directionally in 36° steps (10 steps per revolution), it may be supplied in other configurations.

Maximum rate is up to 60 pulses per sec. The torque is approximately 5 in-oz in the 1¼ x 2½ in. length motor. Nemeth, Inc., 2223 S. Carmelina Ave., Los Angeles 64, Calif.

For more information—
Circle 63, inside back cover



Indicator for Strain Gage Transducers

This indicator consists of a precision d-c meter movement and a d-c power supply, which furnishes excitation for strain gage measurement of fluid and gas pressures, thrust, torque and similar phenomena. Application is suggested by the manufacturer where indication and control of the measured force is to be far removed from the transducer, due to field location or where explosion hazards are involved. Section 30, Taber Instrument Corp., N. Tonawanda, N. Y.

For more information—
Circle 64, inside back cover

Miniature Indicator Light With Plug-in Bulb

A miniature indicator light accommodates a neon or incandescent plug-in lamp, which is replaceable

(Continued on page 263)

—check with

FAIRFIELD!

How long will it take and how much will it cost?—These are points to check whenever you face the problem of setting up production facilities for gears. Special or unusual requirements in design, size, finish, tolerances, materials, and heat treatment are often "standard" at FAIRFIELD.

As one of America's largest independent producers of gears and differentials, Fairfield has every facility needed for quantity production of gears to meet virtually any need. One of the big advantages, *when YOUR GEARS are made at Fairfield,* is that you get the benefits of high production rates and big volume output on all types and sizes of gears. *Your inquiry will receive prompt attention.*

FAIRFIELD
MANUFACTURING CO.
2305 S. Concord Rd. Lafayette, Indiana

Fine Gears and For FINE GEARS *Differentials for:*

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS

new pressure switch

. . . has the appearance and performance you need

Looking for something new, something better, to control or limit the pressure of air, gas, oil? Use this new Honeywell Industrial Pressure Switch . . . designed to complement the most attractive equipment or panels . . . constructed to give lasting performance in the most rugged applications. Use it to make your equipment more automatic, improve your system, provide trouble-free service.

Here are the facts you'll want to know:

- Designed for flush or surface mounting
- Die-cast case is dust and corrosion resistant
- Visible mercury switch position (SPST or SPDT)
- Front-of-case set-point and differential adjustment
- Selection of pressure ranges to 3000 psi
- Specifically designed and constructed for industrial use . . . ½" pipe connection
- Available in explosion-proof construction

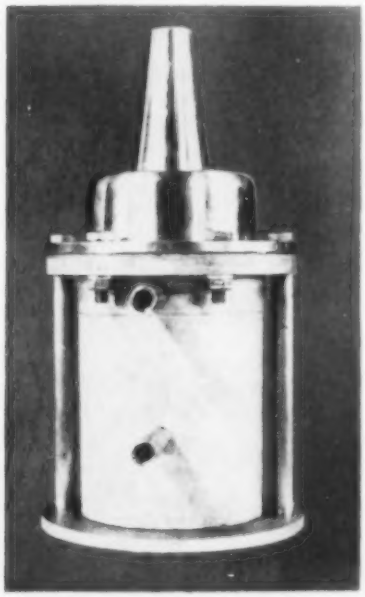
For complete data, a consultation on applications, prices for any quantity . . . get in touch with your local Honeywell sales engineer. He's as near as your phone. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Specification sheet S1011-3 "New Honeywell Industrial Pressuretrol"**

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

from the front of the mounting panel. Requires a mounting hole ⅜ in. dia. Starting voltage of the neon lamp, which is rated at 1/25 w, is 65 to 85 v. Incandescent lamps are available in ratings of 6, 12-14, or 24-28 v. Eldema Corp., 9844 Remer Street, El Monte, Calif.

For more information—
Circle 65, inside back cover



Ultrasonic Transducers

The transducers are designed for use in high temperatures and for developing high amplitude ultrasonic motion, such as drilling, grinding, particle disintegration, molten metal de-

(Continued on page 266)

now you can get this brilliant finish directly on zinc die castings!

No electroplating--no mechanical finishing!

PART AS CAST

TREATED WITH NEW IRIDITE

NEW IRIDITE (Cast-Zinc-Brite)

brightens zinc die castings by chemical polishing, protects against corrosion

NOW, FOR THE FIRST TIME you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

CORROSION RESISTANCE, TOO! New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

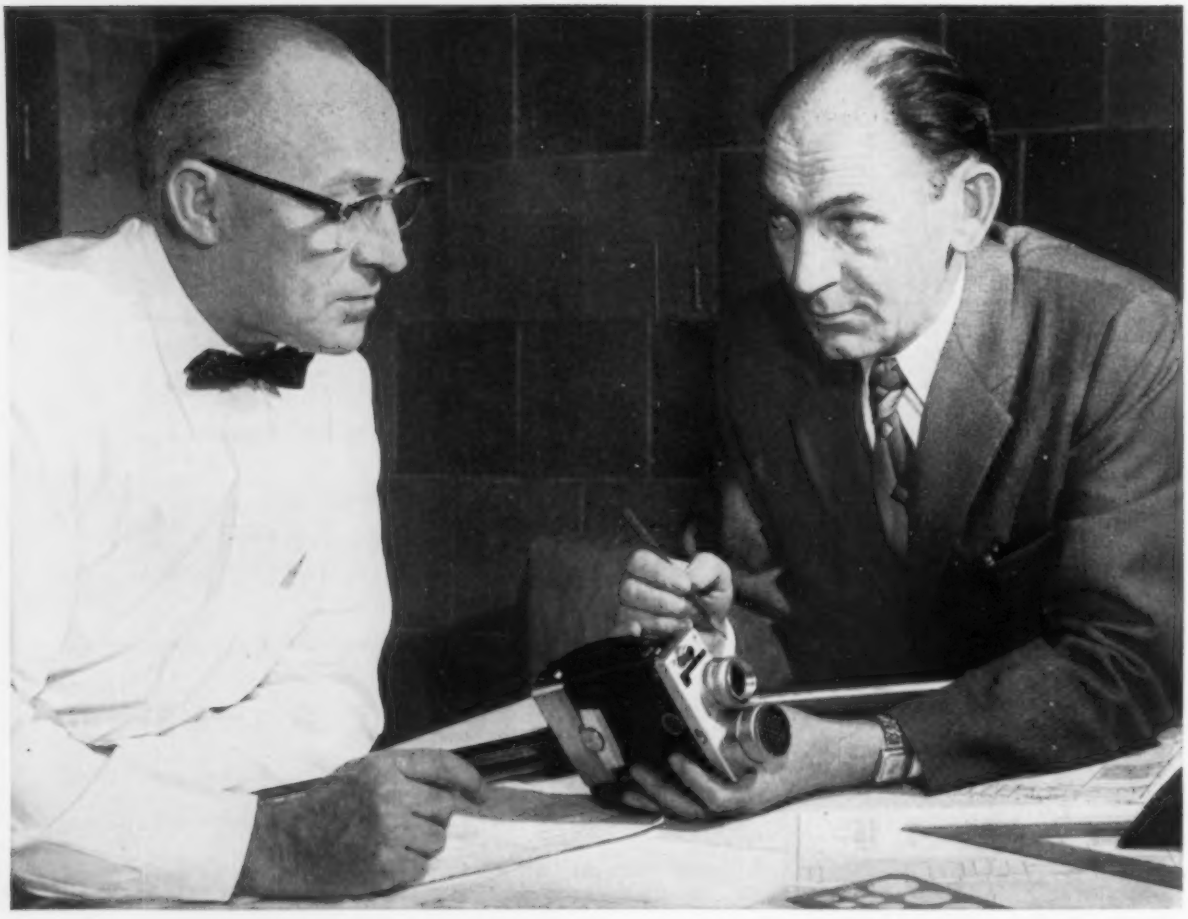
AS A BASE FOR ELECTROPLATING—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.*

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ASP Plating Chemicals



Essential teamwork between design and production departments calls Oscar Riese, left, Superintendent of Metal Parts Manufacturing, into conference with Chief Engineer Paul Richartz, right.

BELL & HOWELL KEEPS COSTS IN SHARP FOCUS AND USES ALCOA SCREW MACHINE STOCK

Competition is toughest at the top. Nobody knows that better than Bell & Howell, world's largest manufacturer of motion picture equipment. On one hand, there's insistence on precision and fine appearance; on the other, emphasis on cost reduction through faster production.

Dilemma? No, because every time Bell & Howell engineers find a new and faster production technique, Alcoa® Aluminum Screw Machine Stock lives up to its end of the job. A classic example is the lens nose for their Wilshire 8 mm camera. The cycle time for drilling, turning, threading, forming, fluting and engraving this part in one complete operation now takes only 1/50 of the period required originally. Even so, surface finish is held to 32 rms, with other tolerances as tight as .001".

Bell & Howell took a long, hard look at every brass part during the shortages in 1951. They weighed aluminum's advantages—corrosion resistance, excellent machinability, light weight, ready availability and the low cost that comes with three times as many parts per pound. As a result, they're designing first for aluminum and using a whopping 300,000 pounds of Alcoa Screw Machine Stock annually.

To the values that prompted Bell & Howell's decision, add electrical and thermal conductivity. If these considerations prompt an analysis of your own requirements in screw machine stock, you'll find a man who can help at your local Alcoa sales office, listed under "Aluminum" in your phone book. Aluminum Company of America, 865-E Alcoa Building, Pittsburgh 19, Pennsylvania.

Bell & Howell Company

finer products through imagination

Lens mounts, control knobs, sprockets, film guide rollers and lens caps are among the typical parts machined by Bell & Howell from Alcoa Aluminum Screw Machine Stock.

Purchasing session brings together Chief Metallurgist Arthur Bartmann, left, and Ernest Van Cleave, right, screw machine stock buyer.

IN PURCHASING

"We started with Alcoa and we've always bought from Alcoa. The fact we've never had a reject on their screw machine stock shows that our confidence is well placed. Technical counsel is another advantage. Alcoa helped us assess the relative values of corrosion resistance and machinability to select the alloy best suited to our needs. In the area of deliveries, we've had wonderful cooperation through coordination of shipments with our production schedules. Finally, since heavy stock removal is characteristic of our operations, resale of scrap is an important factor in material cost."

Checking the part (a telephoto lens mount) against the print are John Weber, left, general foreman, and George Sevick, right, operator.

IN ENGINEERING

"Ours is a quality product, depending on a high caliber of precision and appearance for popular appeal. We value aluminum because it lets us design with assurance that the metal will measure up to our requirements and impose no problems in production. We have found that aluminum gives us the high finish and the perfect match from part to part that good appearance demands. We like the versatility that affords us a choice between plating and anodizing. Light weight, achieved with aluminum, is a significant sales point."

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

IN PRODUCTION

"Concentricity, depth of flutes, diameter of the bore on this lens mount are typical examples of the close tolerances demanded; .001″ is common. Yet, when we find a way to cut production time on a part from more than four minutes down to 49 seconds, aluminum keeps pace with machining speeds. It doesn't punish the tools, so there's less down time for tool changes. And when we're handling 2″ bar stock, its light weight is mighty welcome."

Your Guide to the Best in Aluminum Value

the Best Brake yet for Hazardous Locations

the new DINGS *hazardous-location* MAGNETIC DISC BRAKE

Approved by UNDERWRITERS LABORATORIES

for:

Class I, Group C	Class I, Group D	Class II, Groups E, F, G
Explosive atmospheres containing ethyl ether vapors, ethylene, or cyclopropane.	Atmospheres containing gasoline, benzine, propane, alcohol, lacquer solvent vapors, etc.	Atmospheres containing metal dusts; coal or coke dust; flour, starch or grain dust, etc.

Now you can get the best brake on the market to protect men and machinery in three classes of hazardous locations. Dings "707" Series Hazardous-Location Magnetic Disc Brakes are built to withstand an internal explosion within Underwriters Laboratories limiting requirements for Class I, Group D hazardous locations. Dings "709" Series also meets hazardous location requirements and, in addition, contains a thermal release which automatically releases the brake if the housing temperature approaches the limit set by U. L. for possible ignition of gases, vapors or various dusts included in Class I, Group C or Class II, Groups E, F and G.

Dings new Hazardous-Location Brakes are designed with all the outstanding advantages that make Dings Magnetic Disc Brakes first choice of Motor Manufacturers for either motor mounting or foot mounting.

check the complete line of DINGS *direct-acting* MAGNETIC DISC BRAKES

Eighteen models, with a torque range of 1½ to 175 lbs. ft., meet every requirement, are designed for mounting on all old and new re-rated NEMA type "C" motor flanges and to accommodate standard NEMA shaft extensions.

"THRU-SHAFT" applications for facilitating direct coupling, use of hand cranks, tachometer, plugging switch, pulleys, etc., are easily accomplished by a simple modification of the cover.

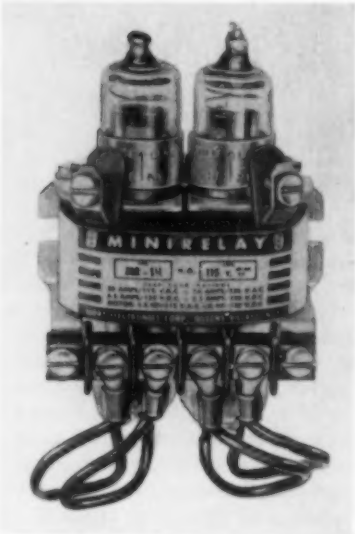
Always specify Dings Brakes from your regular motor supplier . . . or take advantage of Dings complete engineering service for your brake problems. Write for details today.

DINGS BRAKES, Inc.
A Subsidiary of Dings Magnetic Separator Co.
4715 West Electric Ave.
Milwaukee 46, Wis.

DB-257-1/3

gassing, heat treating, ore beneficiation, reduction of running friction. Internally biased, water-cooled, 400 w average, 1600 w peak power magnetostrictive driving elements operating at 25 k per sec are used. These transducers can be driven singly or in groups, by appropriately rated standard ultrasonic generators from 400 w to 10 kw and above. Acoustica Associates, Inc., Glenwood Landing, N. Y.

For more information—
Circle 66, inside back cover



Two-Pole Mercury Plunger Relay

Each contactor tube is rated at 1.5 hp, or 20 amp at 115 v, 10 amp at 230 v and 5.2 amp at 440 v, a-c. In d-c operation they are rated for loads up to 6.5 amp at 120 v and 3.5 amp at 220 v, or ¼ hp.

Any combination of normally open or normally closed contacts is available. Actuating coils are supplied in most standard voltages. Size is 4½ x 2⅜ x 1¾ in. The relay is recommended for control of general purpose, motor and resistive loads, without de-rating. Ebert Electronics Corp., 212-320 Jamaica Ave., Queens Village 28, N. Y.

For more information—
Circle 67, inside back cover

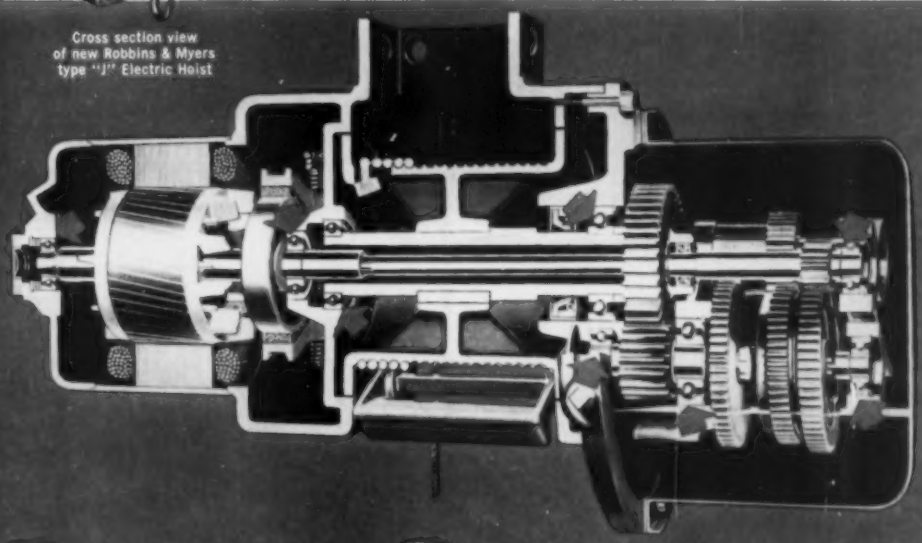
Engine Control Panels

For continuous protection and automatic operation of unattended or remotely-controlled engines on equip-

(Continued on page 270)

9 PROVEN POINTS OF QUALITY ENGINEERING IN A LOW-COST HOIST

Cross section view of new Robbins & Myers type "J" Electric Hoist



The Fafnir 9100K Series ball bearing is designed basically for applications where housing diameters are restricted and maintenance of relatively large shaft diameters is essential. Available with seals or shields.

The Fafnir 200K Series ball bearing is well suited for applications requiring light to moderate loads combined with relatively high speeds. Available with seals, shields, and snap rings in various degrees of precision and retainer construction.

WHEN the design engineers of Robbins & Myers were asked to develop a low-cost electric hoist that would measure up to R & M standards of quality, they made good use of Fafnir Ball Bearings. They specified them to insure precise alignment of parts, conservation of power, minimum maintenance, reserve capacity for long life. In three critical locations they specified Fafnir Plya-Seal bearings — the bearings that provide superior retention of lubricant and positive protection against contaminants. With these and other construction features, they came up with the design of the new Robbins & Myers low-cost, "J" hoist, *quality engineered throughout.*

Fafnir is a supplier of ball bearings for leading industrial hoists, hoist trucks, and hundreds of other industrial machines and equipment where ball bearing advantages improve performance and prolong service life. In case after case, the choice of Fafnir Ball Bearings is influenced by the Fafnir "attitude and aptitude"—a way of looking at bearing problems from the designer's viewpoint and the ability to supply the right ball bearing to fit the need. Perhaps these attributes can help you solve a bearing problem. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

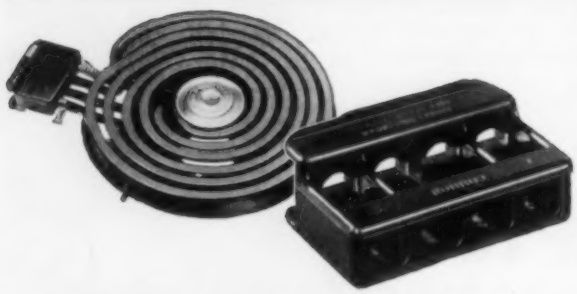
When one of many requirements

Heat resistance with **HIGH STRENGTH**

High strength-to-weight ratio permits slimness in design, a style feature in handles of Bridgeport Brass Company's "Copperware" skillets and saucepans.

Heat resistance plus **DURABLE SURFACE LUSTER**

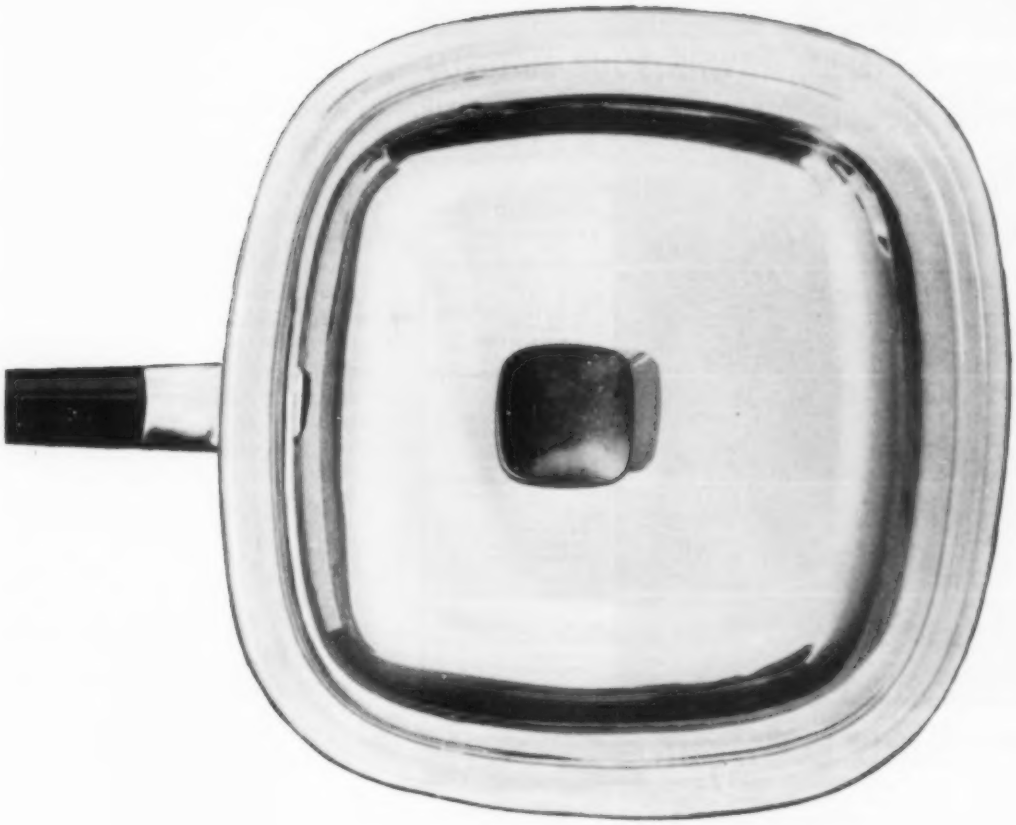
Glossily reflecting highlights, the Duncan Hines Tea-O-Mat's handle of molded Durez has lustrous beauty that will not fade.



Heat resistance plus **EXCELLENT ELECTRICAL PROPERTIES**

Dependable service in everyday use is safeguarded by Chromalox Microtube terminal blocks of Durez phenolic in these slim-tube range units.

is **HEAT RESISTANCE**



get the others too...with

DUREZ PHENOLICS

Solutions to three separate problems furnish a graphic example of why engineers turn to the reliable Durez thermosetting phenolics when planning new products or improving current models. In all three, heat resistance happened to be a basic requisite. Yet each required a different combination of other properties from the other two for success.

For more than thirty-five years Durez has been a gold mine of useful properties for the designer. In close-tolerance components resistant to impact, high and low temperatures, water, and chemicals... and wherever good electrical characteristics are essential... you can usually do it better with Durez. These materials also help you hold the cost line, due to their uniformity and excellent molding behavior. Many are designed for easy preforming and molding in automatic machines.

For data and for information on new developments in these versatile plastics, keep in touch with your molder... call on our field engineering service... or let us send you "Durez Plastics News."

DUREZ®

Phenolic Plastics that Fit the Job

DUREZ PLASTICS DIVISION

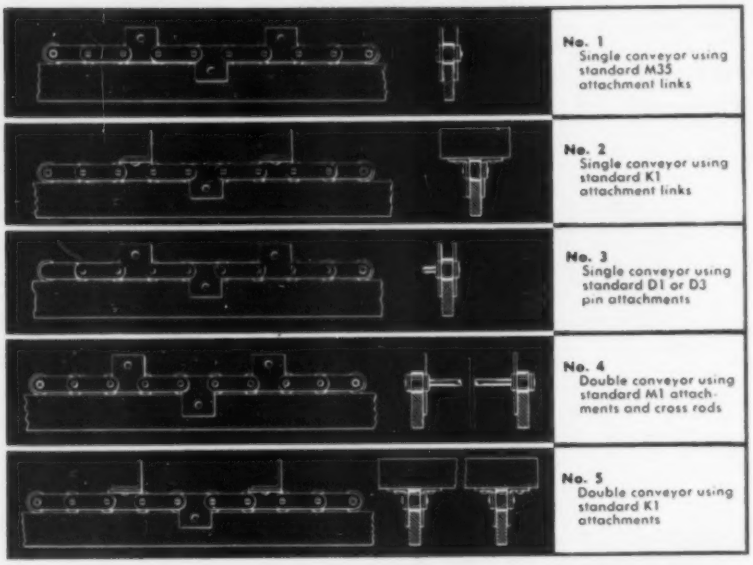
HOOKER ELECTROCHEMICAL COMPANY

1506 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICALS PLASTICS

automation

YOU CAN CUT COSTS BY MOVING YOUR MATERIAL WITH *ACME* DOUBLE PITCH CONVEYOR CHAINS


No. 1
Single conveyor using standard M35 attachment links
No. 2
Single conveyor using standard K1 attachment links
No. 3
Single conveyor using standard D1 or D3 pin attachments
No. 4
Double conveyor using standard M1 attachments and cross rods
No. 5
Double conveyor using standard K1 attachments

DOUBLE PITCH ROLLER CHAINS

Double pitch conveyor chains, sometimes known as extended pitch chains are becoming increasingly more popular in many industries where high grade finished roller chains are required, at a lower cost than the standard pitch chains. This series was developed on the basis of using standard round parts of the standard series and doubling the pitch. For example double pitch chain #C-2080 which is 2" pitch utilizes the same round parts as 1" pitch heavy series chain #80H.

In addition to being applicable for slower speed power transmission drives these chains are widely used as conveyors for the handling of materials. A standard line of attachments are available that gives this line great versatility in reference to incorporation of cross flights, cross rods, etc., that are applicable for conveyor work.

The double pitch series of chains are widely used in the Agriculture Implement, Baking Machinery, Construction Machinery, Mining, Packaging, Textile industries, etc.

Figure 8 Side Plates, Standard Rollers

Figure 8 Side Plates, Oversize Rollers

Straight Side Plates, Standard Rollers

Straight Side Plates, Oversize Rollers

SPROCKETS

Sprockets for Double Pitch Chains can be furnished in either SINGLE TOOTH FORM OR DOUBLE TOOTH FORM, as shown on the right.

Double tooth cutting actually doubles the life expectancy of the sprocket.

Chain rollers contact only every other tooth. When these teeth become worn after long service, the sprockets can be advanced one tooth, thus permitting chain engagement on a new series of sprocket teeth.

Double pitch chains can be furnished in either Figure 8 or straight side plate type. with standard or oversize rollers.

Single Tooth Cutting — Double Duty Tooth Cutting

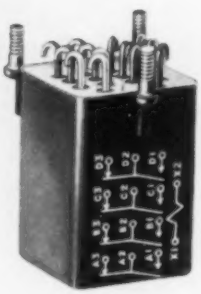
FREE CATALOG
Write Dept. 1M for new illustrated 76 page catalog on use and application of roller chains and sprockets.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Call *ACME* for Service

ment like irrigation pumps, oil rigs, air compressors, generator sets, fork-lift trucks, refrigeration machines, these safety panels automatically shut off engines, should oil pressure drop to a dangerously low level or engine water temperatures rise too high. Available for both battery and magneto-type ignitions, as well as diesels, these expandable panels include pre-cut holes for insertion of tachometer, hour meter or other instruments or gages, as needed. Oil or water pressure level and maximum engine temperature, at which it is desired to shut off the engine, are factory-set but may be adjusted to suit. All equipment can be used on 6, 12, 24 or 32 v circuits. Stewart-Warner Corp., 1826 Diversey Pkwy, Chicago 14, Ill.

For more information—
Circle 68, inside back cover



Four-Pole Relay

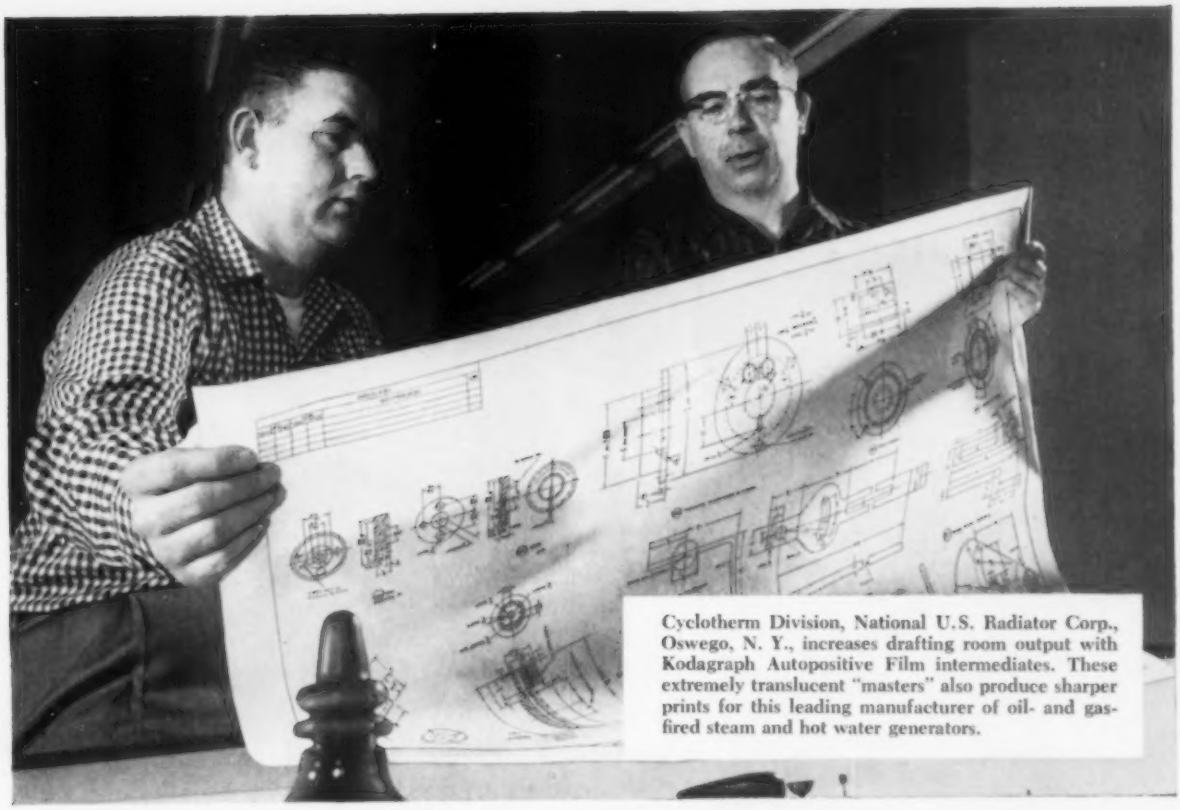
Contact rating of this relay is 10 amp resistive at 30 v d-c and 115 v, 400 cps. Overload limit is 60 amp. Coil is rated 26.5 v d-c, 170 ohm. Recommended for temperature range of −65 C to 125 C; vibration: 30 g to 2000 cps. Weight is 5 oz. Allied Control Co., Inc., 2 E. End Ave., New York 21, N. Y.

For more information—
Circle 69, inside back cover

Damping Device Uses Eddy Currents

This device employs eddy-current principles to provide a torque for damping control of linear or rotary forces. The torque is developed by transmitting an input force through a precision gear train, which rotates a disc across permanent high intensity

(Continued on page 274)



Cyclotherm Division, National U.S. Radiator Corp., Oswego, N. Y., increases drafting room output with Kodagraph Autopositive Film intermediates. These extremely translucent "masters" also produce sharper prints for this leading manufacturer of oil- and gas-fired steam and hot water generators.

"Like having 6 times the drafting room force"

AT CYCLOTHERM, jobs that once took days are now done in hours. For example—several draftsmen prepare segments of large drawings simultaneously. Then these units are taped on a form, which is reproduced on Kodagraph Autopositive Film. Result: A sparkling new drawing in no time at all.

Another big time-saver—Cyclotherm's complicated drawings must be changed constantly to meet customer requirements. No redrafting . . . drawings are reproduced on Autopositive Film. Unwanted detail is removed . . . new detail drawn in.

Cyclotherm also uses Autopositive Film to provide duplicate tracings for its record file . . . supply "reproducibles" to customers . . . reclaim old, dog-eared drawings.

Kodagraph Autopositive Film is the ideal material for all these applications. It is durable, highly translucent, and has good dimensional stability. Also, it permits exceptionally fast print-back speeds, produces truly sparkling results, is photo-lasting in the files. So convenient to use, too . . . requires no darkroom, is exposed on a standard contact printer. *And it prints directly to a positive, eliminating the negative step.*

EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N.Y.

Kodagraph Reproduction Materials

New booklet is jam-packed with valuable tips on saving drafting time, protecting drawings, getting better prints. Shows how you, or your local blueprinter, can process these low-cost materials with existing equipment. Mail coupon for your free copy.

MAIL COUPON TODAY

EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N. Y.

Gentlemen: Please send me a free copy of your new booklet on Kodagraph Reproduction Materials. 15-5

Name_____
Position_____
Company_____
Street_____
City_____
Zone____ State_____

Kodak
TRADE MARK

See the Louis Allis "Syncro-Spede"

See the Louis Allis "Syncro-Spede" in action at the Design Engineering Show, New York Coliseum, May 20th to 23rd, Booth 417-419.

They look like twins — but one is synchronous

Louis Allis "Syncro-Spede"* offers—for the first time—a synchronous motor in the same frame sizes as a standard induction motor

New from Louis Allis — *the most compact and efficient synchronous induction motor on the market* . . . the revolutionary "Syncro-Spede." It's the *only* synchronous motor built in standard NEMA frames for comparable ratings in any enclosure.

The space-saving "Syncro-Spede" has no external excitation, wound rotating fields, collector rings or brushes—offers simplified control and low-cost operation, virtually maintenance-free.

In performance, "Syncro-Spede" delivers and maintains exact synchronous speed within its rated capacity, regardless of load variations or voltage dips. When powered by a single adjustable frequency source acceleration, running speed, and deceleration of several different ratings of "Syncro-Spede" motors can be synchronized.

"Syncro-Spede" is the low-cost answer to such demanding synchronous applications as *precise adjustable-frequency multi-motor systems* . . . high-frequency generator drives and constant-speed conveyor drives . . . precision timing and metering devices . . . recording instrument drives . . . any system requiring constant speeds from no-load to full-load.

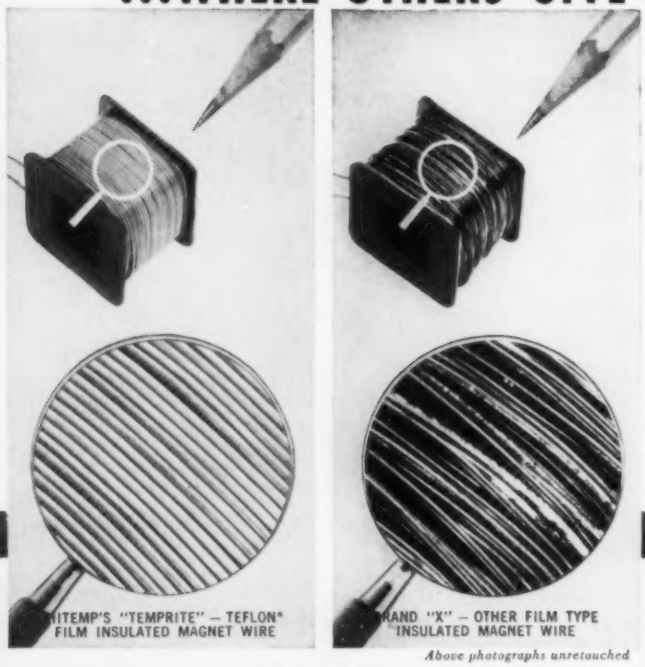
"Syncro-Spede" sizes range up to 100 hp. For information and expert application engineering assistance, contact your nearby Louis Allis District Office or write directly to The Louis Allis Company, 458 East Stewart Street, Milwaukee 1, Wisconsin.

*"Syncro-Spede" is a trademark of the Louis Allis Co.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

HITEMP WIRES STAND UP ...WHERE OTHERS GIVE UP



HITEMP'S "TEMPRITE" – TEFLON* FILM INSULATED MAGNET WIRE

AND "X" – OTHER FILM TYPE INSULATED MAGNET WIRE

Above photographs unretouched

IN MAGNET WIRE FOR COMPONENTS

THERMAL TEST: 168 HOURS AT 500° F.

The above illustrations clearly show the tremendous thermal advantage of Hitemp's "Temprite," Teflon* insulated magnet wire, over the best of other film-type insulations. Here is a true Class H magnet wire, with an amazing upper temperature level of 500° F.

Ask yourself! How will the component I manufacture be used? If your coils, relays, transformers, motors etc. must withstand today's high temperatures and frequencies; if moisture, chemicals or solvents will be encountered; if abrasion resistance and film continuity are a must or if **miniaturization** is important... Hitemp's "Temprite" must be specified.

For **maximum reliability** and **unequalled performance** specify "Temprite" . . . the magnet wire made to exceed the requirements of military specification MIL-W-19583. Available in sizes 14 to 50 AWG inclusive and in single, heavy, triple and quadruple thicknesses.

For further information call or write your nearest Hitemp Wires, Inc. representative or sales engineer today!

Leading Specialists in High Temperature Insulations

HITEMP **WIRES**

INC.

26 WINDSOR AVENUE, MINEOLA, NEW YORK

NATIONAL REPRESENTATIVE

MINNESOTA
Ken Mills
5230 Culver Road
Minneapolis, Minnesota

EXPORT
GT. BRITAIN & W. EUROPE
Hartley-Baird Ltd.
37-39 Thurlow Street
South Kensington
London S.W. 7, England

WASHINGTON, D. C. GOVERNMENT
John W. Houston, Jr.
1625 "K" Street, N.W.
Washington 6, D. C.

NEW YORK & NEW JERSEY
Par Distributors
240 Old Country Road
Mineola, New York

LOS ANGELES & CENT. CAL.
C. B. Rush & Associates
3757 Wilshire Blvd.
Los Angeles 5, Calif.

FLORIDA
Larry Johnson, Suite 219
561 N.E. 79th Street
Miami 38, Florida

KENTUCKY AND OHIO
Gallagher Company
15 Ritchie Avenue
Cincinnati 15, Ohio

TEXAS
General Power Equip. Co.
5623 Dyer Street
Dallas 6, Texas

NO. & SO. CAROLINA
Larcol Engineering, Inc.
123 Brevard Court
Charlotte 1, N. C.

S. CALIF., ARIZONA AND NEW MEXICO
Fred W. Faick Co.
2311 West Burbank Blvd.
Burbank, California

UPPER N. Y. STATE
Philip L. Rirsh
223 Windemere Road
Rochester 10, N. Y.

CANADA, VIRGINIA, W. VA., MISS., LOUISIANA, PA.
Aeronic Accessory Co.
161 Orinoco Drive
Brightwaters, N. Y.

SAN FRANCISCO & N. CAL.
Bill Kolans & Co.
3580 20th Street
San Francisco, Calif.

NEW ENGLAND
Richard H. Whitehead, Jr.
Guilford, Connecticut

MARYLAND AND DELAWARE
Sol W. Goodman
32 West Biddle Street
Baltimore 1, Maryland

OREGON AND WASHINGTON
Ray Johnston Company
11009 Evanston Avenue
Seattle 33, Washington

OKLAHOMA
Joseph Turner
4140 South Peoria
Tulsa, Oklahoma

ALA., TENN. & GEORGIA
C. H. Emory Equip. Co.
P. O. Box 9013
Birmingham 9, Alabama

WRIGHT FIELD
Jack J. Carney & Assoc.
905 Knott Building
Dayton 2, Ohio

MICHIGAN
Jim Morrow Sales
85 Lenore Avenue
Highland Park, Mich.

INDIANA
Richard C. Warner
Box 316
South Whitley, Ind.

ILLINOIS, WISC. & IOWA
Caine Sales Company
2020 North Cicero Ave.
Chicago 41, Illinois

*Du Pont's Trade Name for POLYTETRAFLUOROETHYLENE

currents produce a damping torque which is directly proportional to the input speed of rotation. Operating temperature range is from −100 F to 300 F. A range of damping rates is available, from 50 in-lb/rad/sec to 1250 in-lb/rad/sec. Lyndon Aircraft Corp., 140 Clifford St., Newark 5, N. J.

For more information— Circle 70, inside back cover

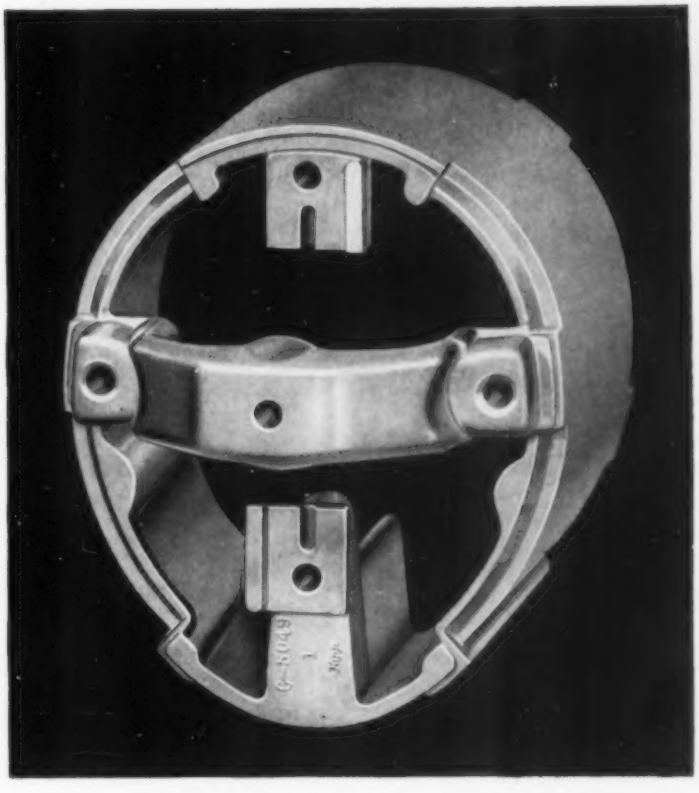
Miniature Relay

An aircraft-type relay, four-pole, double-throw, with a sealed coil within its hermetically sealed case has an inorganic, simplified switch, to provide reliability in dry circuit applications. The device can be stored indefinitely and operated at temperatures from −65 C to 125 C, without danger of contaminating the contacts. The coils are separately sealed and completely isolated from the switch. Contacts are specially cleaned before assembly and sealing. The complete assembly occupies 1.6 cu in. These relays will carry up to 10 amp in power circuits. Standard contact ratings in-

(Continued on page 276)

Full Process Utilization

. . . the telling factor



Thin sections, brackets, holes, bosses, counterbores and oval shape all produced in a split second—from molten metal. No other process can compete with this for eye appeal or low cost.

with MADISON-KIPP zinc and aluminum die castings

The Die Casting process has many advantages over other commonly used processes, but full process utilization requires the rare mechanical skills that are not only predominate but also seasoned, at Madison-Kipp.

This long-time experience in die casting has been of value to highly placed designers and engineers for over a quarter century.

Please clip this ad as a reminder to contact us when you have die casting requirements.

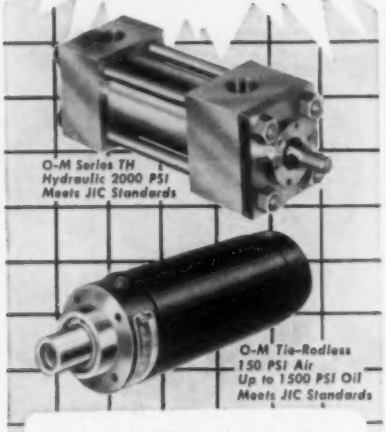
kipp

MADISON-KIPP CORPORATION
206 WAUBESA STREET • MADISON 10, WIS., U.S.A.

Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

O-M cylinders
(AIR AND HYDRAULIC)

are an integral part of AUT O-MATION



Look for the big O-M in Aut-OM-ation! Today's high speed Automation Program demands high quality, dependable Air and Hydraulic Cylinders—Cylinders able to maintain today's pace with a minimum of attention. This is why you'll find more and more O-M Cylinders right in the middle of Aut-OM-ation.

O-M Tie-Rodless Cylinders (Round Line)—150 PSI Air—Up to 1500 PSI Oil—Compact in design "To Fit Where Others Won't"—with the lowest co-efficient of friction and easily serviced when necessary. Versatile mounting and port orientation.

O-M Tie-Rod Cylinders (Series "TH")—2000 PSI Oil—Equipped with removable rod gland cartridge for easy maintenance. The modern improved version of the square, tie-rod cylinder, designed to give the best in performance.

All cylinders available in full range of sizes (1½" through 8" bores) with standard and heavy-duty piston rods.

Mail coupon today for Bulletins 101A and 105

ORTMAN-MILLER MACHINE CO.
15 143rd Street, Hammond, Ind.

☐ Have representative call
☐ Send Bulletins 101A and 105

Name_____ Position_____

Company_____

Address_____

City_____ Zone___ State_____

clude 30 v d-c; 115 v a-c; 2, 5, 7½ and 10 amp, resistive; 2 and 5 amp, inductive, with special ratings available to 350 v d-c, 400 ma. Other combinations include up to 20 amp. Coils are available with resistances of 1 to 50,000 ohm. Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.

For more information—Circle 71, inside back cover

Electromagnetic Miniature Clutch

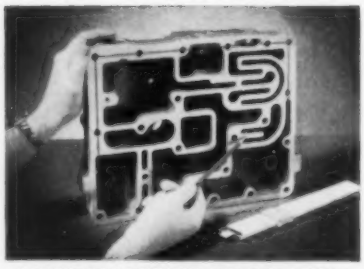
Designed for use on low torque drives of instruments and control mechanisms, the clutch is said to give instantaneous, positive engagement and release of loads up to 2 in-lb (static torque rating). Axial length of the unit is ⅜ in. and diameter 1⅛ in. No slip rings or brushes are required, since the flange-mounted field is connected through pigtail leads to a 28 or 90-v d-c source. In the clutch, torque is transmitted through the rotor to the armature, which may be keyed to the driving or driven member. Power required is 6 w max. Warner Electric Brake & Clutch Co., Beloit, Wis.

For more information—Circle 72, inside back cover

Subminiature Relay for Printed Circuits

A relay with lug arrangements for use on printed circuits can be adjusted for as low as 10 milliw pull-in and is equipped with solid brass terminals, plated or not as desired. Contacts of fine silver or other suitable alloy permit upwards of 25 w of power

(Continued on page 280)



MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

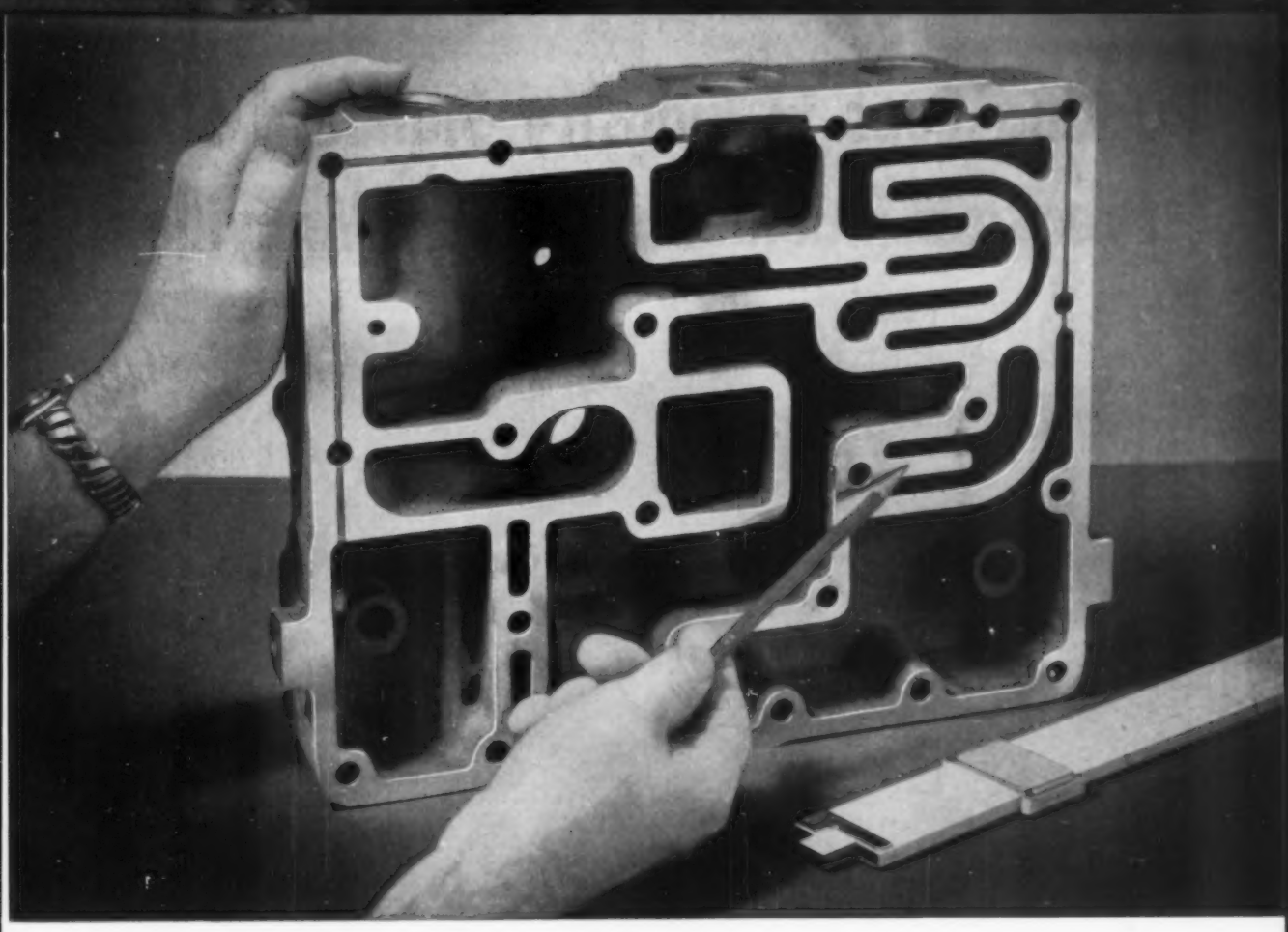
The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Empire Pattern & Foundry Co., Tulsa, Okla.
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundry Co., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
The Prescott Co., Menominee, Michigan
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

Send for your free single copy

This handy Meehanite Wheel Chart 7G contains complete physical specifications.

Write today to Meehanite Metal Corporation, Department 7G, 714 North Avenue, New Rochelle, New York.

MEEHANITE®



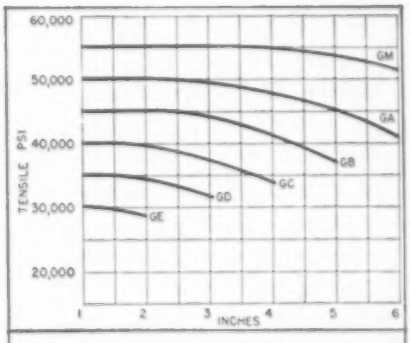
Rigidly controlled Meehanite metal assures uniform physical properties in all sections of complex castings.

This extremely complex Meehanite casting was made in large quantities for use in the production of military tanks. Every casting had to be completely free from defects in order to pass exacting inspection standards and uniformly high physical values were required, despite a number of intricate sections which varied from ¼″ to 2″ in thickness.

Meehanite metal may be poured in both heavy and light sections, minimizing the danger of draws, shrinks, openness of grain and varying physical properties. Containing a controlled quantity of graphite in a pearlitic matrix, Meehanite castings shrink 50% less than steel during solidification, hence eliminating casting strains, warping and cracking.

The uniformity and control of the microstructure of Meehanite castings results in high strength, improved wear resistance, excellent vibration damping, dimensional stability, good machinability and many other engineering advantages.

For more information write today for a free copy of the Meehanite Wheel Chart M-6 which contains complete physical specifications.



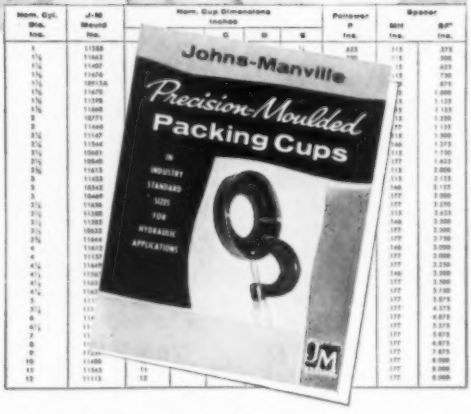
Effect of increasing casting dimension on tensile properties of Meehanite castings.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK

Packing Cups in Industry Standard Sizes Precision-moulded by Johns-Manville



Ask for new size list and compound color code of these J-M Packing Cups

Made in the original *square heel* design, developed and perfected by Johns-Manville, these cups are precision made to assure maximum efficiency.

They are available in a variety of styles and compounds to suit most pressures, temperatures and fluids. For easy identification, cups are marked with a different color stripe for each compound.

Complete dimensions, compounds, code and piston design data are in folder PK-107A. Write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ont.

JOHNS-MANVILLE PRODUCTS

Johns-Manville PACKINGS, GASKETS and TEXTILES

MAY
1957

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

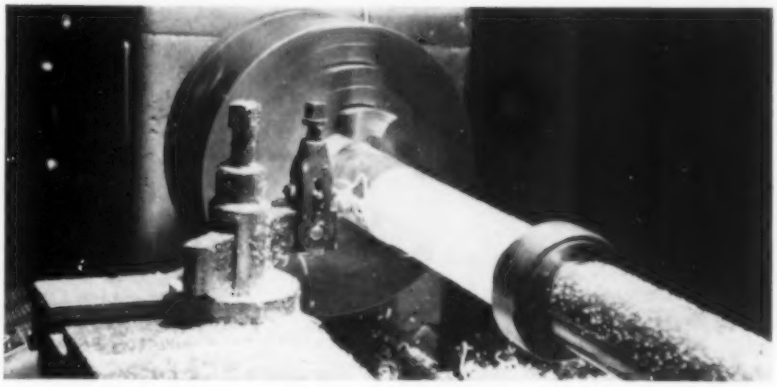
DOW

DATA NOW AVAILABLE ON MACHINING AND MECHANICAL FINISHING OF STYRON

MACHINING AND FINISHING OPERATIONS ON STYRON REQUIRE CORRECT EQUIPMENT AND CAREFUL TECHNIQUES

Continuing studies, under the direction of Dow Plastics Technical Service, have resulted in the compilation of extensive data on Styron® finishing. Critical factors such as heat distortion temperature, rigidity, and residual stress of Styron parts have been investigated in an effort to develop proper cutting tools to be used.

Machining of Styron is not difficult when the nature of the material is thoroughly understood and certain basic principles are followed. In most cases, ordinary metal and wood finishing equipment, with some modification, can be used.



Styron is a thermoplastic material which can soften and distort under heat. And, since most machining operations produce heat, mechanical finishing of Styron introduces problems not encountered when working with wood or metal. Surface temperature, for example, must be kept below 140°F. This may be accomplished by reducing friction and providing for proper chip clearance. In many cases, excessive heat generated must be removed by the use of a coolant, either gas or liquid.

Dow Plastics Technical Service has tested drills, taps, threading dies, saws, punching dies, buffing equipment and other tools. Technical Service engineers have compiled a detailed study of all factors involved in the machining and mechanical finishing of Styron parts, which you may obtain by writing for a copy of "Machining and Mechanical Finishing of Styron".

This is only one phase of study under the direction of Dow Plastics Technical Service. Continuing plastiatrics investigations cover every phase of plastics formulation, design, molding and finishing.

For confidential assistance on your plastics problem, and for detailed technical information, write today to THE DOW CHEMICAL COMPANY, Midland, Mich., Plastics Sales Dept. PL 1542G.

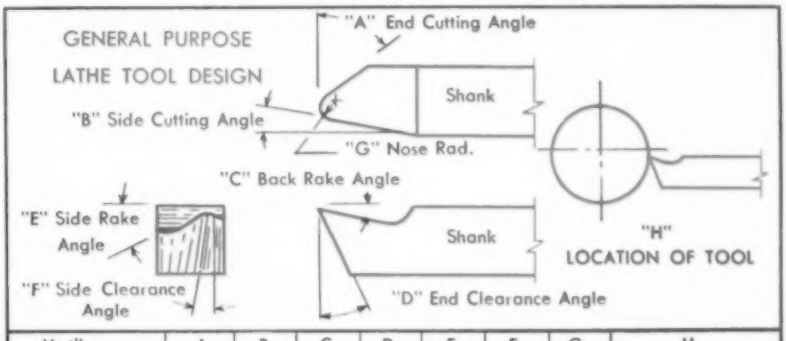
AMERICA'S FIRST FAMILY OF POLYSTYRENES

GENERAL PURPOSE
- STYRON 666
- STYRON 665 (Extrusion)
- STYRON 688 (Easy Flow)
- STYRON 689 (Easy Flow)

HIGH IMPACT
- STYRON 475
- STYRON 777 (Medium Impact)
- STYRON 440 (Heat Resistant)
- STYRON 480 (Extra-High Impact)

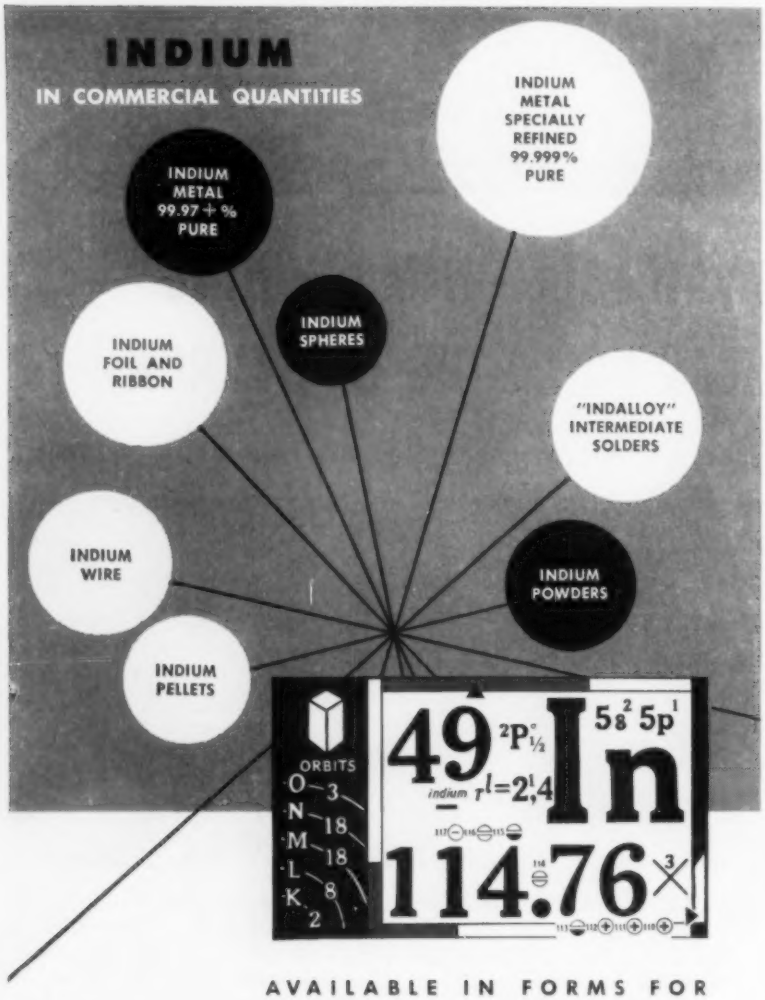
HEAT RESISTANT
- STYRON 683
- STYRON 700

GENERAL PURPOSE LATHE TOOL DESIGN



Mat'l.	A	B	C	D	E	F	G	H
Med. Steel	20°	10°	+8°	6°	14°	4°	3/16	At ℄
Polystyrene	20°	10°	−2°	12°	10°	10°	3/16	2° above ℄

YOU CAN DEPEND ON DOW



AVAILABLE IN FORMS FOR INDUSTRIAL APPLICATIONS

When you think of INDIUM, think of The INDIUM Corporation of America as your first source of supply.

Through years of research and experimentation, we have developed the techniques of producing INDIUM in quantities for use by industry. Along with our ability to supply INDIUM in various forms, we also offer technical help in its applications to your own product development.

Our experience is at your service.

QUALITY
at the Indium Corp. of America means: purity of metals, and strict adherence to specifications.

SERVICE
means prompt delivery to customers, and technical help in specific uses of Indium.

RESEARCH
means "forward looking" with respect to new products and new techniques.

WRITE FOR

New Indium Bulletin . . . "Nomographic Charts of Pellets and Spheres . . . Weights per Thousand in Grams — with Alloy Analysis Equation."

THE **INDIUM** CORPORATION OF AMERICA
1676 LINCOLN AVENUE UTICA, NEW YORK
Since 1934 . . . Pioneers in the Development and Applications of Indium for Industry.

control for non-inductive applications. The capacity of the contacts for inductive loads is suitably de-rated. Contact shapes and materials can be arranged for larger wattages and various inductive loads. Jaidinger Mfg. Co., Inc., 1921 W. Hubbard St., Chicago 22, Ill.

For more information—
Circle 73, inside back cover

Fluid Pressure Measuring Cells

A differential pressure cell with increased capacity and accuracy for measuring fluid pressure has three capacities of differential pressure: ±15, 30 and 60 psi. Line pressure capacity is up to 90 psi. Linearity is up to 1/10% full scale. Dept. HN 104, Baldwin-Lima-Hamilton Corp., Waltham, Mass.

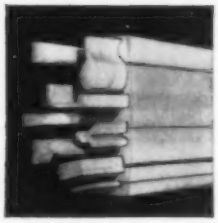
For more information—
Circle 74, inside back cover

Magnetic Line Voltage Regulator

Designed primarily for unattended or industrial electronic applications, this voltage regulator employs a buck-boost transformer between line and load, with reversible-phase power supplied by a motor-driven continuously variable autotransformer. The motor

(Continued on page 284)

YOU CAN DO MORE THINGS



You can form continuous-strip mouldings with a hot wire cutter, or die cut it so easily ordinary cookie cutters have been used . . .

It can be molded in place for integral contour shapes, cemented or sewn to almost any type of covering material.

more ways . . . better . . . faster . . . more economically with **urethane foam**

Can you use a material that can be tailor-made softer than velvet, lighter than cork, tougher than leather, more elastic than rubber, warmer than wool, easier to work than wood? That's versatility—the profitable kind—and it's all yours with urethane foams.

Urethane foams are an entirely new group of synthetic materials, developed by Mobay for modern fabrication and design techniques. Pronounced structural strength, marked stability to heat, dry-cleanable and washable, good insulating properties (thermal, sound and electrical) and ability to bond during foam reaction to almost any type of material, are among their most outstanding properties.

If you manufacture or use anything that requires cushioning or insulation—where light weight, structural strength, vibration dampening and durability are desirable factors—your first step should be to get the full story on urethane foams. Write to **Mobay Chemical Company, Dept. P-1, St. Louis 4, Missouri.**

An associate company of Monsanto

Mobay supplies basic chemicals for the manufacture of urethane foams which are already in use or under development for these applications

Auto safety padding
Furniture upholstery
Carpet underlay
Interlining for outerwear
Footwear
Household items.

MOBAY®

First in Urethane Chemistry

It is so tough you can hog-ring it right to seating springs without backing support or fabric liners . . .

You can tack or staple it to wooden frames, back rests or arm rests . . . roll or crimp to suit your fancy . . .

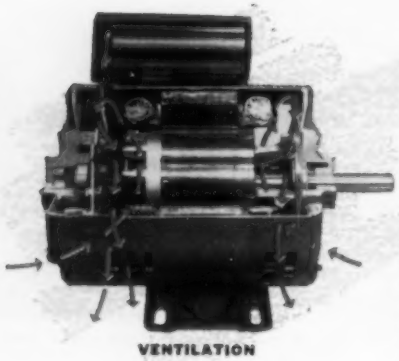
You can bond it securely to almost anything with standard cements . . . or heat-seal it to many materials . . .

You can slice it so thin it has the drape and feel of velvet . . . quilts to fabrics with standard equipment . .

It is so easy to tailor you can cut it with ordinary scissors or power-driven pattern cutters . . .

available in . . .
SPLIT PHASE,
PERMANENT SPLIT CAPACITOR,
CAPACITOR START-INDUCTION RUN,
POLYPHASE

NEW!



VENTILATION

CLEAN, MODERN DESIGN—Lightweight, die-cast aluminum head ends accurately fit precision machined steel body, assuring rigidity and good alignment. External finish is smooth, flaw-free . . . blends well with any color.

IMPROVED, DOUBLE-END VENTILATION—Ventilating fans are integral with die-cast aluminum squirrel cage rotor, providing effective cooling of the windings from both ends for long life. Properly located openings give maximum cooling with minimum internal parts exposure.

MYLAR* POSITIVE INSULATION—Mylar* polyester film laminated to rag paper insulates slot cells and other strategic areas. Excellent dielectric qualities and resistance to tearing and aging, affording virtually permanent protection against dust, moisture and heat damage.

CHOICE OF MOUNTINGS, BEARINGS—Rigid, welded base or vibrationless, ultra-quiet resilient mounting with motor hubs floating on rubber cushioning rings permanently bonded to inner and outer metal bands. Either sleeve type or fully sealed ball bearings available. If desired, special construction permits re-lubrication of ball bearings. Bearings seat in precision bored steel rings cast into the aluminum heads.

**DuPont registered trademark*

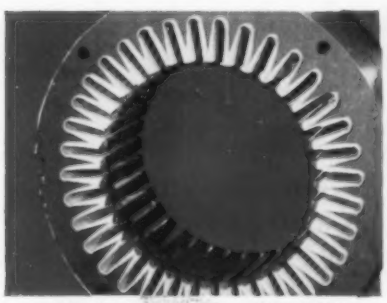
Robbins & Myers build motors
from 1/200 to 200 horsepower

R&M

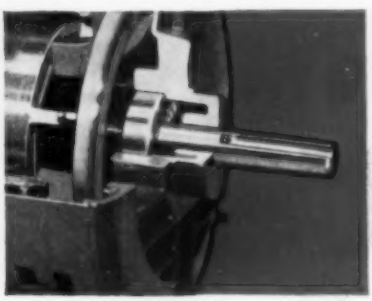
R & M's BROAD LINE OF SMALLER, LIGHTER, FRACTIONAL HP MOTORS

Robbins & Myers Re-Rated Frames 56 and 48

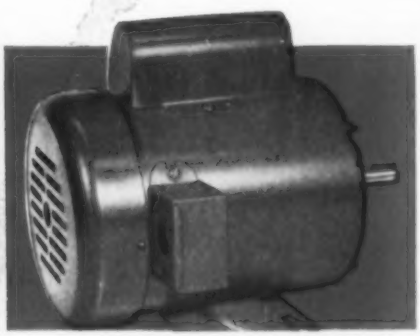
Here's a dynamic new motor—smaller, lighter, more versatile than older frame motors—yet with undiminished performance and reserve power. Completely new R&M "Model R" fractional horsepower motors will perform dependably and enhance the appearance and acceptability of your products. They range from 1 to $\frac{1}{8}$ HP in types for all your applications: polyphase, permanent split capacitor, capacitor start single phase and (in the smaller ranges) split phase types. Designed in new NEMA frames 56 and 48, they are *lighter* due to new applications of aluminum, steel and copper . . . *smaller* thanks largely to a unique new ventilating system . . . *more versatile* because of weight, size and many other design features involving frames, mountings, insulation etc. Look over the big advantages these motors offer you! Then write today for R&M Bulletin No. 450–PE.



MYLAR SLOT CELL INSULATION



BEARINGS



TOTALLY ENCLOSED—FAN COOLED

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

MOTORS FANS HOISTS MOYNO PUMPS INDUSTRIAL PROPELLAIR FANS

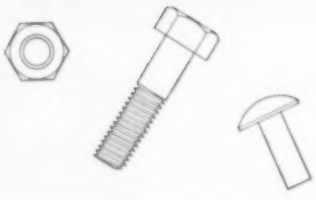
LIVE BETTER ELECTRICALLY

150,000,000 Standard Fastenings... Bolts, Nuts, Screws, Rivets, Washers ready for IMMEDIATE DELIVERY

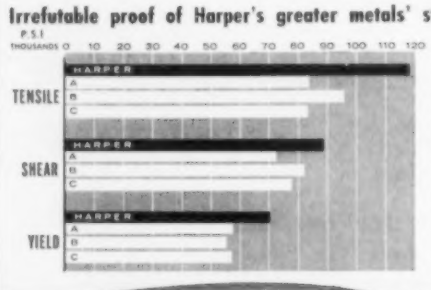
Be Specific . . . Don't Compromise . . . get the exact corrosion-resistant fastenings you need—right away—from your nearby Harper Distributor. He stocks thousands and thousands of them to give you quick service. He's an expert in fastenings and will give your order specialized attention. Why shop? Why wait? He has what you need . . . on hand BEFORE you order. They're as near as your phone. Call your local Harper Distributor today for immediate delivery.

THE H. M. HARPER COMPANY
8203 LEHIGH AVENUE · MORTON GROVE, ILLINOIS

HARPER®

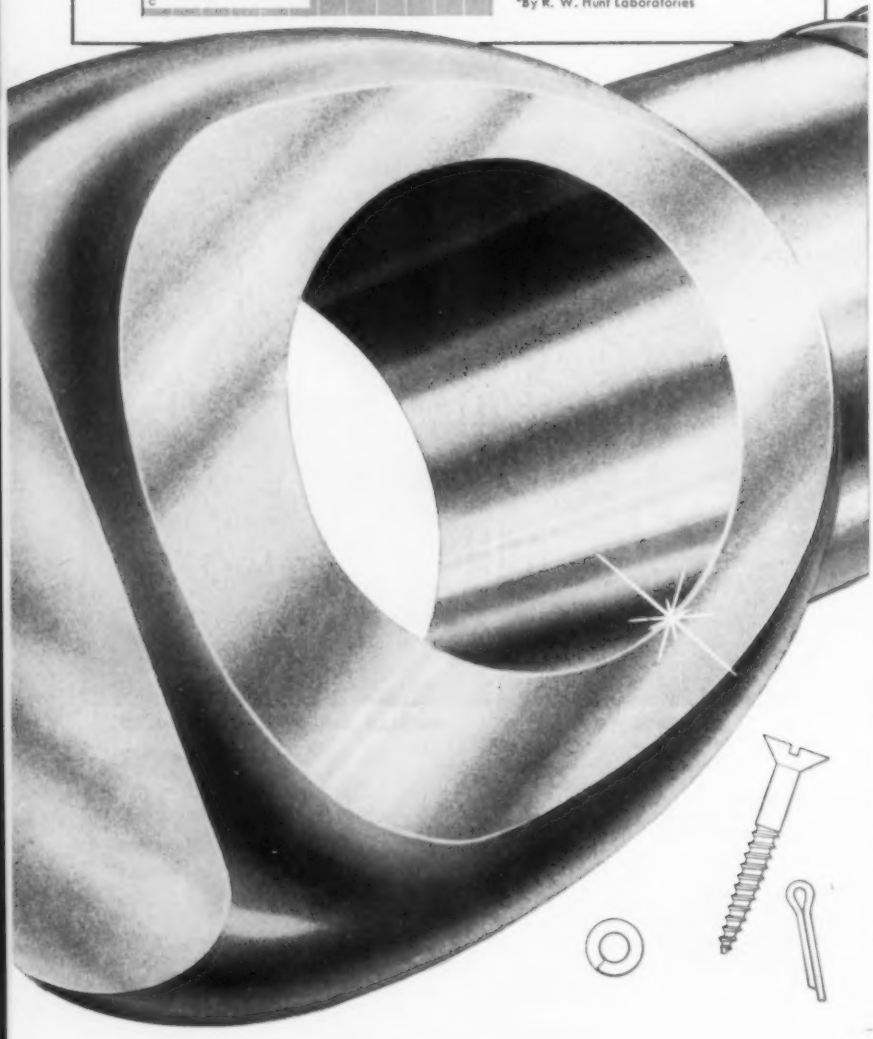


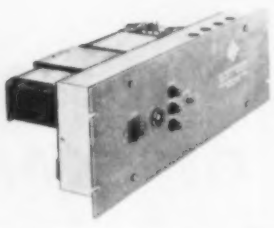
Irrefutable proof of Harper's greater metals' strength shown by laboratory test!



An important point in buying fastenings is strength. Independent laboratory tests*, utilizing Stainless Steel Machine Bolts by Harper and three other leading producers, prove Harper superiority in Tensile, Shear, and Yield Strength. The chart at left shows the actual results of these tests. For complete information on these important tests, request Form No. 126.

*By R. W. Hunt Laboratories





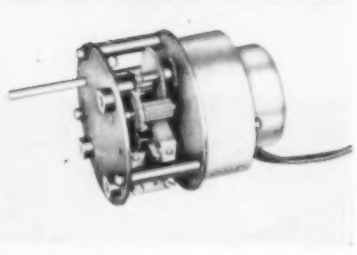
is controlled by a two-stage magnetic amplifier, sensitive to output voltage changes. Selenium and silicon rectifiers are used throughout. Input voltage is 108-132 v, or 96-144 v, 50-65 cps. Output voltage is 105-125 v, adjustable, nominal 120 v; Output current: 25 or 12.5 amp max at 120 v. Accuracy is said to be ±1% on output, for any combination of load, input voltage and frequency within ratings. Kenyon Transformer Co., Inc., 840 Barry St., New York 59, N. Y.

For more information—
Circle 75, inside back cover

Diaphragm for Up to 500 F

By combining a glass fabric with one of the new silicone rubbers a diaphragm seal has been developed which will function within a temperature range of −80F to 500 F. Bellofram Corp., Burlington, Mass.

For more information—
Circle 76, inside back cover



Solenoid-operated Clutch Motors

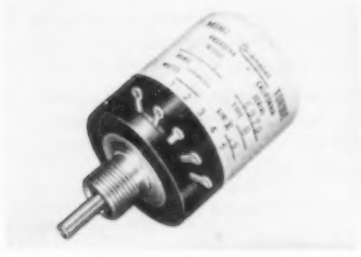
These clutch motors consist of a motor driving one of the inputs of a differential and a solenoid-operated finger stopping or releasing the other input. The output of the differential connects directly to the output shaft. The output shaft is disconnected entirely from the motor gear train when not in use.

The full running torque of the mo-

(Continued on page 285)

tor may, therefore, be used to start a load. A high torque load may be started because the running torque of the motor is normally twice the starting torque. This clutch provides instantaneous clutching at high speeds, reducing the effect of motor lag. The clutches are available with clockwise or counter-clockwise outputs. Output speeds range from 60 rpm to as low as 1 rev per month. The available output torque is limited to the developed torque of the motor used, and should never be more than 20 in-oz for optimum life. All motors and clutches are rated for 115 v, 60 cps applications, in standard units. Bristol Motor Div., Vocaline Co. of America, Inc., Old Saybrook, Conn.

For more information—
Circle 77, inside back cover



Low-torque Potentiometer

This instrument has a heavy duty, 0.125 in. stainless steel shaft mounted on miniature shielded ball bearings. Available in resistance ranges from 100 to 100,000 ohm, the potentiometer measures 1 in. dia. The 0.6 oz torque rating makes this unit suitable for applications where no appreciable loading can be tolerated. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

For more information—
Circle 78, inside back cover

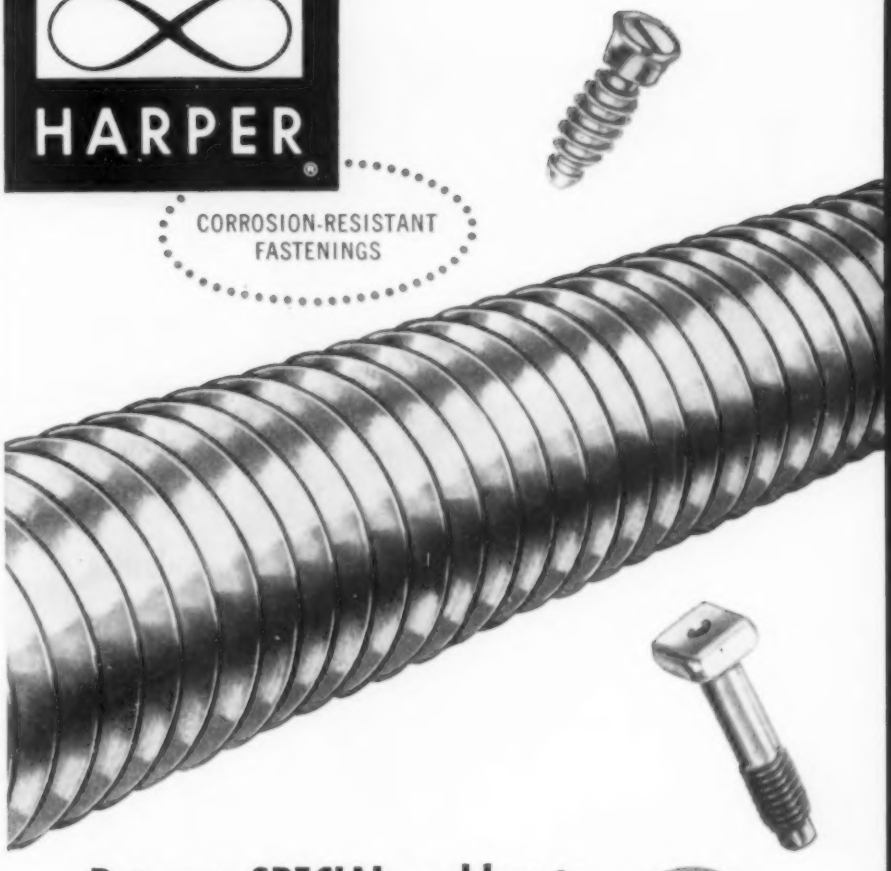
Temperature Probes

These probes use thermistors as temperature sensing elements. They were designed for airplane and missile applications, and other environments where small size is important. They are available with nominal resistance from 1000 ohms to ½ megohm or more at 25 C. Resistance tolerance is ±20%, as supplied by themistor manufacturers. Maximum operating temperature is 500 F, and the thermistors

(Continued on page 286)

HARPER®

CORROSION-RESISTANT FASTENINGS



Put your SPECIAL problem to the Harper FLO-FORM team

This small but tricky eyebolt (reproduced here in giant size) was redesigned and produced by Harper at a 50% saving. The Harper Flo-Form Process employs highly special techniques to produce parts of economical design, with greater strength and durability, and *without* scrap loss. Call on the Harper Flo-Form engineering team of design, metallurgical, and tooling specialists to help you save dimes to dollars on parts which you find costly to manufacture. Use their more than 33 years of know-how. See what you, too, can save on corrosion-resistant fastenings and special parts. Send your problem today to The H. M. Harper Company and ask for the Flo-Form catalog.

Meet Harper Application Engineer, KEVIN MULROY

New York City's highly specialized manufacturing plants have Harper Application Engineering Service available to them from Mr. Mulroy. Kevin, working with the Harper Flo-Form Engineering Team, provides solutions to daily problems of industry from small electronics to shipbuilding.

THE H. M. HARPER COMPANY
8203 LEHIGH AVE., MORTON GROVE, ILLINOIS

The Harper infinity symbol, as shown above, and the name FLO-FORM are registered trade marks of The H. M. Harper Company.

how to
LEAKPROOF A BOAT...

...or any product made of aluminum, steel, glass or plastics

Holes are drilled in aluminum sections, No. 590.5 applied to faying surfaces, backing easily removed, then sections riveted together. (Photo courtesy Orlando Boat Co., Orlando, Florida.)

...with PRESSTITE
oil, gasoline, water resistant sealers

On water, on land or in the air, Presstite-Keystone's No. 590.5 Seam Sealing Tape forms a permanently watertight and leakproof seal that will not dry out or crack, retains its plastic characteristics to −65°F., and is resistant to gasoline or oil. Nor will it craze plastics. It's easy to use, too . . . no mess or clean-up.

Extruded in convenient roll form, No. 590.5 is always of uniform thickness. Available from .020″ to .0625″ thick and widths from ½″ to 3″.

No. 590.5 is an aircraft-type sealer and complies with Military Specification Mil-S-7126a.

WANT A SAMPLE? *Write us today on your company letterhead*

PRESSTITE SEALING COMPOUNDS
PRESSTITE-KEYSTONE ENGINEERING PRODUCTS COMPANY
K A P

A Division of AMERICAN-MARIETTA COMPANY
3750 CHOUTEAU AVENUE, ST. LOUIS 10, MISSOURI

have been aged for two weeks at this temperature.

The probes use rigidly anchored screw terminals, although pigtail leads can be supplied. All structural parts are Type 303 stainless steel. The sensing element is insulated from ground and is calibrated at 0 and 100 C. Rosemount Engineering Co., Rosemount, Minn.

For more information—
Circle 79, inside back cover

Teflon Insulating Tape

This tape is said to retain electrical properties over a temperature range of −100 F to 500 F. Dielectric constant is between 2.00 and 2.05. The tape is available in colors and natural white in various widths and thicknesses. Chemo-Textile, Inc., P.O. Box 169, W. Warwick, R. I.

For more information—
Circle 80, inside back cover

Cyclic Control

Designed for making accelerated life tests on a range of electrical and mechanical devices, this testing unit provides on-off power cycles that may be adjusted to any period from $\frac{1}{10}$ sec to 15 min.

Operates from 117 v, 60 cps power, and will make and break circuits up to 15 amp. A counter is optionally avail-

(Continued on page 291)

KEY to a revolution in electrical design— Reynolds Aluminum strip conductors

Aluminum Strip Conductor becomes its own insulation through anodizing—a process by which the non-conductive film of aluminum oxide, natural to aluminum, is deepened. This revolutionary conductor and its companion product, Reynolds Interleaved Strip Conductor, used with a very thin layer of insulation between windings, make many more aluminum advantages available to electrical design. Both conductors are now available as a result of Reynolds pioneering research.

Space and weight are saved in coils and transformers—and there's up to 50% savings in conductor material costs. Aluminum Strip Conductors provide added conductive area without increasing the space now required with copper wire. Space formerly taken up by insulation and voids in round wire windings is eliminated.

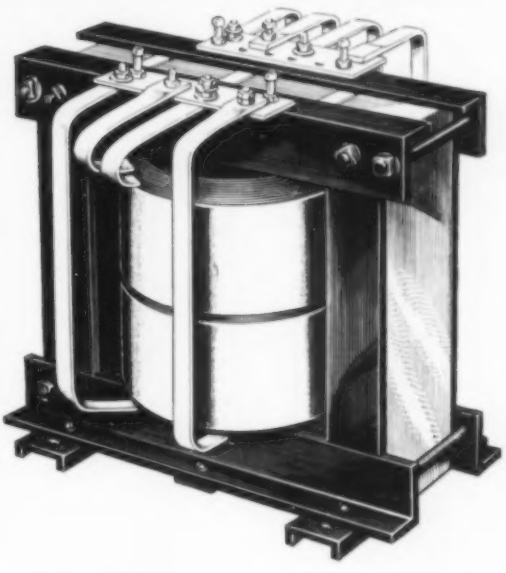
Heat dissipation is greatly improved because each coil winding is externally exposed and because of aluminum's high rate of heat transfer. Hot spots are eliminated, cooling ducts usually not needed. Electrical performance is increased because of lower average operating temperatures.

For all aluminum applications, advantages like this are available through Reynolds Design and Engineering Services. You can gain most from the strength, light weight and versatility of aluminum by asking these men to work with you on design problems. For their assistance call the Reynolds Office listed under "Aluminum" in your classified phone directory. Or write *Reynolds Metals Company, P.O. Box 1800-HN, Louisville 1, Kentucky.*

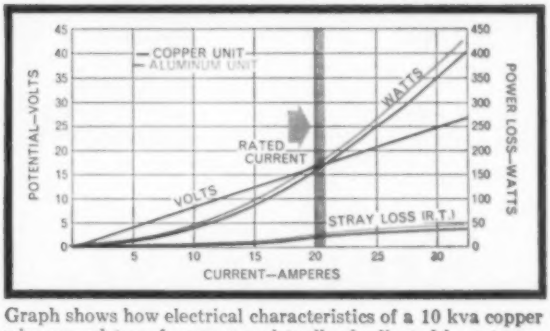
The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

See "CIRCUS BOY", Reynolds exciting dramatic series, Sundays, NBC-TV

VISIT THE REYNOLDS ALUMINUM EXHIBIT at the Design Engineering Show New York Coliseum—May 20-23



CONDUCTOR LOSS AND IMPEDANCE

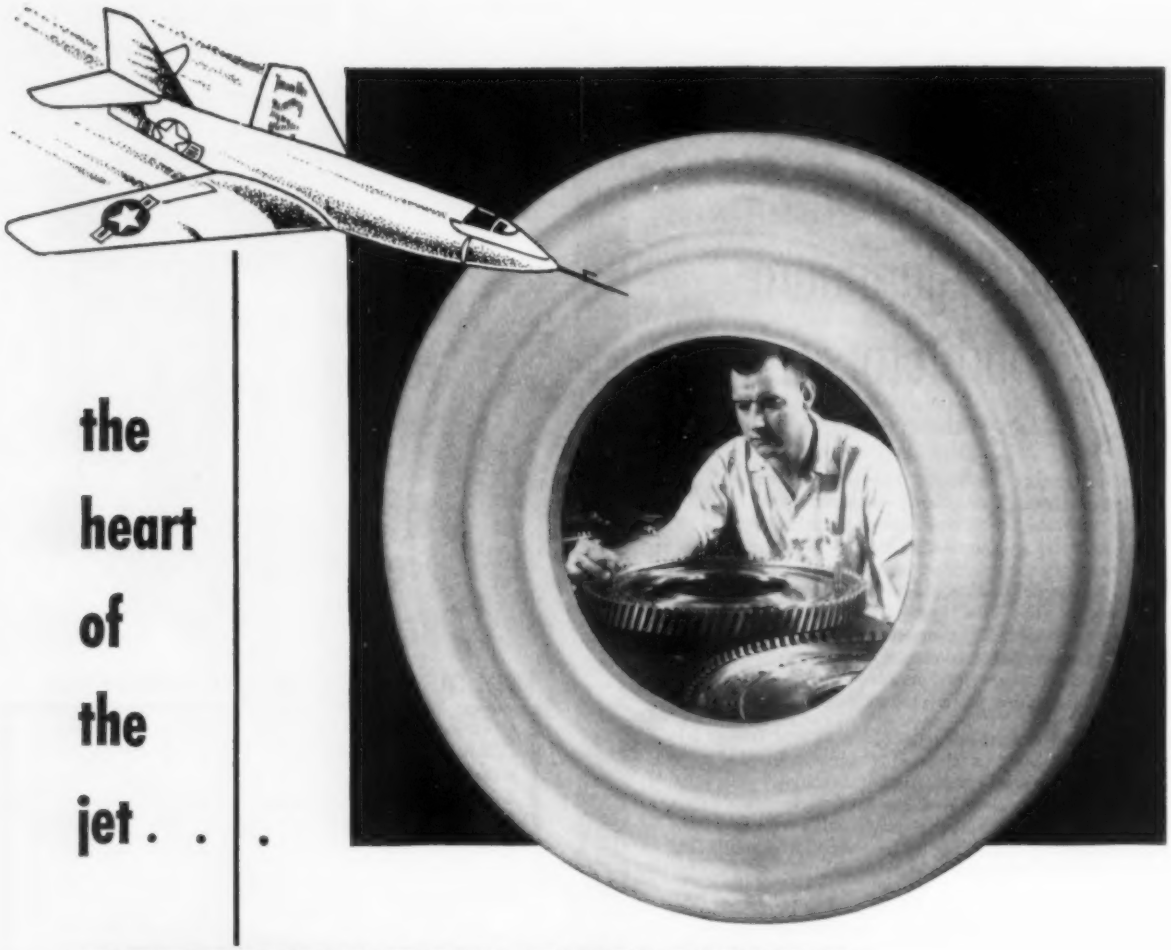


Graph shows how electrical characteristics of a 10 kva copper wire wound transformer are virtually duplicated by a transformer with Reynolds Aluminum Strip Conductor wound in exactly the same physical space as conventional copper coils.

WEIGHT AND COST

COILS:	SQUARE COPPER DOUBLE GLASS INSULATION	ALUMINUM ANODIZED FILM INSULATION
CONDUCTOR SIZE		
PRIMARY	1—#6 GA	1—.008x3¼
SECONDARY	2—#6 GA	2—.008x3¼
TURNS:		
PRIMARY	2 COILS—84 TURNS	2 COILS—84 TURNS
SECONDARY	2 COILS—42 TURNS	2 COILS—42 TURNS
COIL WEIGHT	41 lbs	20 lbs
PRICE $/lb	$0.77	.....
CONDUCTOR COST, $	$31.57	APPROX. 50%
CORE (SHELL TYPE) WEIGHT	132 lbs	132 lbs
CROSS-SECTIONAL AREA		
CENTER SECTION	14.625 in.²	14.625 in.²
YOKE	20 in.²	20 in.²

Here is a comparison of 10 kva—480/240—240/120 transformers of conventional copper design and with Reynolds Aluminum Strip Conductor in exactly the same physical space. Note that aluminum strip design saves approximately half the conductor cost and weight.



the heart of the jet . . .

— DEPENDABLE FORGINGS —

Ever since the beginning of the development of mechanical power, the heart of power producing machinery has been forgings.

The latest development in the field of mechanical power is the aircraft turbo-jet engine. Here again, the important highly stressed components — the turbine wheels and the compressor discs — are forgings and here also more of these forgings are produced by Wyman-Gordon than by any other company.

Entirely new problems, mechanical and metallurgical, are involved in the production of these vital parts — problems which require the maximum in experience, know-how and research facilities. Wyman-Gordon excels in all of these areas and continues today as for nearly 75 years in the forefront of new forging developments.

Seen through the porthole of this compressor disc is the finished forging — an example of the ultimate in quality and precision.

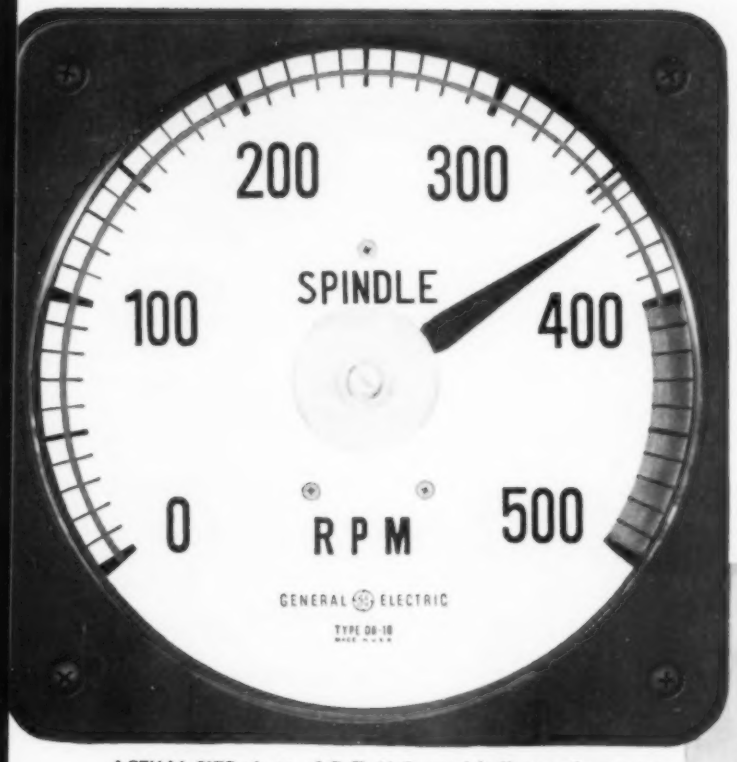
WYMAN-GORDON COMPANY

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

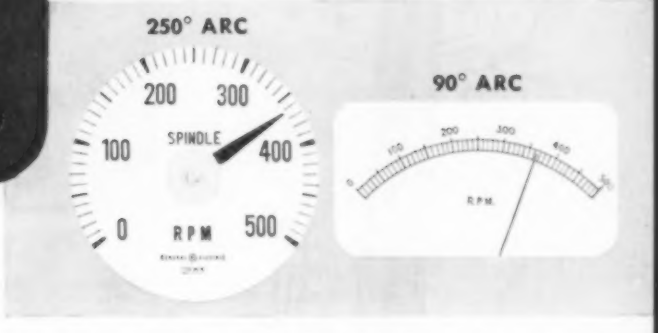
WORCESTER 1, MASSACHUSETTS

HARVEY, ILLINOIS • DETROIT, MICHIGAN

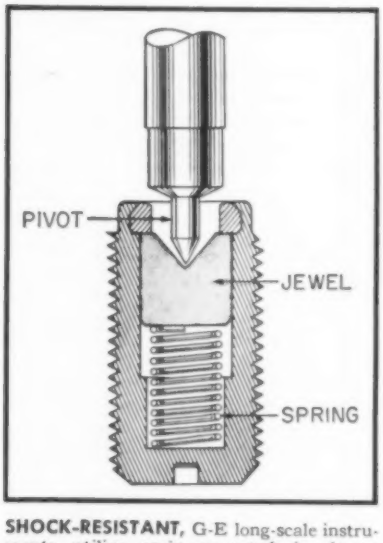


GENERAL ELECTRIC
SPEED-MEASURING SYSTEMS OFFER:

Improved Readability; Shock-Resistant Pivot Design



ACTUAL SIZE photo of G-E 4¼" speed indicator shows ease of readability made possible by shadow-proof glass, 250-degree scale, and large numerals. See the difference that the longer scale and larger numerals make (right). This design is also available in an 8¾-inch instrument.



SHOCK-RESISTANT, G-E long-scale instruments utilize spring-mounted jewels to cushion pressure on pivot points. Bevel-shouldered pivots ride against retainers to help protect against "mushrooming."

Improved readability and sustained accuracy even under difficult conditions of shock and vibration are two major benefits of the long-scale speed-measuring instruments. Used with any of the complete line of General Electric a-c or d-c tachometer generators, these handsome indicators provide a speed-measuring system with features unmatched by other equipment.

SHOCK RESISTING PIVOT DESIGN

Sustained accuracy of reading even under difficult conditions is made possible by the shock resisting spring-mounted jewel and pivot design of these instruments. This construction practically eliminates pivot "mushrooming" and resultant sticky pointer action caused by shock and vibration incurred in high-speed applications.

SYSTEM ACCURACY OF ±1%

All General Electric speed-measuring systems incorporating long-scale instruments are factory calibrated for an accuracy of ±1% of full scale. Any errors that occur in a-c systems due to rectifier aging can be eliminated by periodic adjusting of the rheostat at the base of the indicator, another exclusive feature.

RECORDERS ALSO AVAILABLE

For recording and controlling speed, General Electric also offers a line of electronic, servo-operated, round-chart recorders and recording controllers. Special circuits are available for measuring differential speed, speed ratio, speed deviation from a fixed reference, and the reciprocal of speed or "time in process." For some models, accuracy is as high as 0.1% of measured speed.

For recording only, you can use General Electric's versatile CH recorder with the enclosed, throw-away inkwell that minimizes spilling and eliminates cleaning.

WRITE FOR BULLETINS

For more detailed information, call your nearest General Electric Apparatus Sales Office or write for descriptive bulletins to Section 585-71A, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

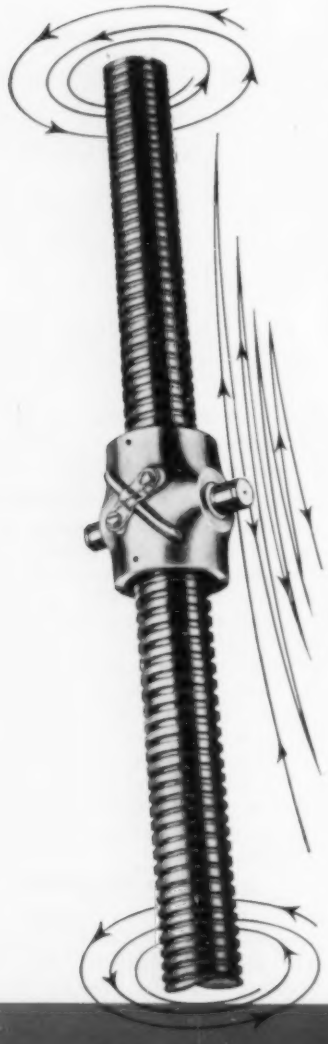
1957 DESIGN ENGINEERING SHOW

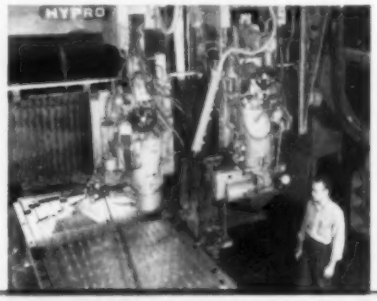
VISIT BEAVER — BOOTH 324

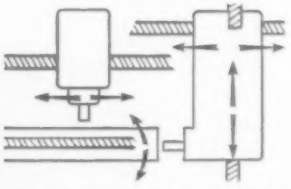
NEW YORK COLISEUM MAY 20 to 23

Beaver has given the ball screw, far older in principle than any of its present manufacturers, a new importance. Beaver Ball Screws, for converting torque to thrust, are of such precision that builders of machine tools and other power equipment requiring extreme accuracy are rapidly turning to their use for controlling the positioning of heads, etc. As an example of a Beaver attainment, a ball screw was recently delivered in which the cumulative lead error was less than .001″ in approximately 11 feet of ball thread! This was regarded as impossible to achieve until Beaver did it. Beaver Ball Screws, preloaded and free of backlash, with low breakaway torque and high reversibility where required, provide the precision and efficiency demanded in adapting numerical control to machine operations.

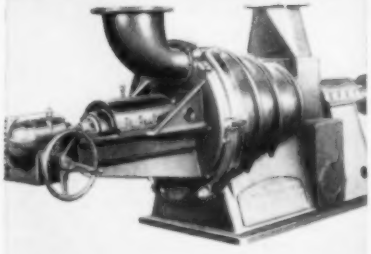
Beaver Ball Splines offer like precision and efficiency in eliminating the friction of sliding splines and keyways.

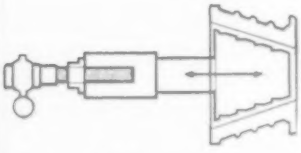




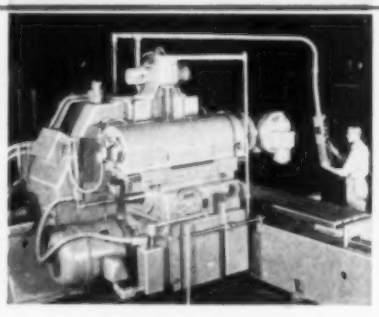


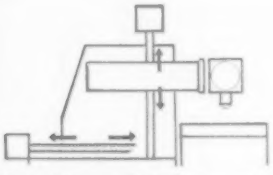
Four Beaver Ball Screws automatically position heads and swivel work chuck of numerically controlled skin mill.





Beaver Ball Screw permits fast easy adjustment of blades for control of stock characteristics in paper Jordan.





Here Beaver Ball Screw raises 14,000 pound machine tool head with 4 H.P. motor and without bulky counterbalancing.

Beaver Ball Screws are engineered to the specific application and not to preconceived standards. Can we help you improve your product? Literature and engineering consultation service available. Write now.

Beaver Precision Products INC.
CLAWSON, MICHIGAN

Contact Your Nearest Beaver Engineer

CALIFORNIA
W. A. Owen & Associates
10419 Long Beach Blvd.
Lynwood (L.A.), California
'Phone: LOraine 7-8887

ILLINOIS
N. W. Dorr Company
5807 W. Division Street
Chicago 51, Ill.
'Phone: CO 1-6667

MASSACHUSETTS
Lindco
1023 Southbridge Street
Worcester 3, Massachusetts
'Phone: PLeasant 6-4637

MICHIGAN
Beaver Precision Products Co.
Sales Department
651 N. Rochester Road
Clawson, Michigan
'Phone: LIncoln 5-0580

George B. Nelson Co.
1636 Division Ave., South
Grand Rapids 10, Michigan
'Phone: CHerry 1-2551

MINNESOTA
Industrial Representatives Co.
3562 Dakota Avenue
Minneapolis 16, Minnesota
'Phone: WE 9-2664

NEW YORK
Windheim Tool Company
145 University Avenue
Rochester 5, New York
'Phone: BAker 6745

OHIO
Horace S. White Company
3035 Sandra Place
Cincinnati 38, Ohio
'Phone: HUmboldt 1-2759

Wood-Compton Company
3666 East 116th Street
Cleveland 5, Ohio
'Phone: SKyline 1-6122

PENNSYLVANIA
Tools Incorporated
86 Bethlehem Pike
Philadelphia 18, Pennsylvania

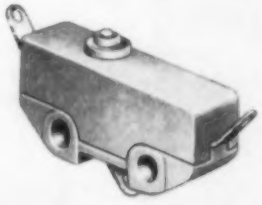
Ralph A. Hiller Company
4133 Brownsville Road
Pittsburgh 27, Pennsylvania
'Phone: TUxedo 2-7353

WASHINGTON
Marbel Associates
1016 First Avenue, South
Seattle 4, Washington
'Phone: ELliott 5007

Beaver Precision Products INC.
CLAWSON, MICH.

able to register accumulated test cycles. Paraplegics Mfg. Co., Inc., 10068 Franklin Ave., Franklin Park, Ill.

For more information—
Circle 81, inside back cover

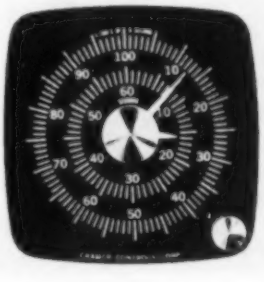


Miniature Switches

These switches measure $\frac{33}{64}$ x $\frac{13}{32}$ x $\frac{1}{4}$ in. They can be ganged together to perform multiple switching functions in confined areas.

Each switch is available according to specifications as single-pole, normally open, single-pole, normally closed or single-pole, double-throw. The characteristics are 5 amp resistive at 28 v d-c, 5 amp resistive at 115 v a-c. They will operate satisfactorily −65 F as well as 250 F. Hayden Switch, Inc., Waterbury, Conn.

For more information—
Circle 82, inside back cover



Electrical Stop Clock

An electrical stop clock with instantaneous electrical reset ($\frac{1}{10}$ sec) and accuracy of 0.02% is hemetically sealed and designed to meet vibration and shock conditions. It is available for either local or remote reset. Where local reset is desired, a pushbutton is provided on bezel. On the sealed timer, pushbutton actuates reset solenoid through a bellows.

Load switches rated 5 amp to 250

(Continued on page 292)

COMPLEX DESIGNS?

SIMPLE DESIGNS?

You Need the Special Advantages of Engineered Lubricants from ANDEROL

Whether you are designing a simple mechanism such as a parking meter, or a complex gyroscope . . . a Lehigh Lubrication Specialist will be pleased to recommend a special Anderol Engineered Lubricant to meet your specific needs. Call on him while your product is still in the design stage. Regardless of volume or requirements, Lehigh will engineer a special Anderol Lubricant to do the job.

FOR MORE INFORMATION

See us at
Booth No. 305-307
Design ENGINEERING SHOW
May 20-21
or write DEPT. 26.

ANDEROL
ENGINEERED LUBRICANTS
Lehigh Chemical Company
CHESTERTOWN, MARYLAND

HOW TO

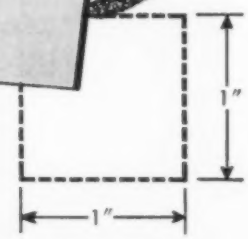
CONTROL MORE THAN

7,000 functions

IN THIS CONFINED AREA

with 3 dimensional

CAMS



Yes, in less than one square inch, about the area of an ordinary postage stamp, the output of the Parker 3 D cam can be expressed as a dependent variable . . . the resultant of two known independent variables which can produce precision functions in split seconds!

$$z = f(xy)$$

where z is the output of the 3 D cam; *x* and *y* are the two known variables.

These functions transferred through a follower assembly can activate:

AIRCRAFT—Jet Fuel Injection, Missile Control, Navigational Control, etc.

MACHINE TOOL—Automation Functions Repetitive Production, Feed Back Functions, etc.

COMMERCIAL—Pre-computed Functions Stored Information, Mental-Mechanical Functions, etc.

by Parker

Send today for FACT FILLED brochure—"3 Dimensional Cams." See how Science SAVES SPACE, produces MECHANICAL SOLUTIONS IN SECONDS!

THE PARKER-HARTFORD CORPORATION

CAM DIVISION

FRANKLIN AVENUE • HARTFORD, CONNECTICUT

by Parker

v a-c, resistive, operated from cams on either fast or slow pointer shafts, can be supplied. Number of pulses per second or minute, and duration of pulses, are factory set. With switches on both fast and slow pointer shafts (wired in series) it is possible to use the clock as a precise time delay or interval timer.

Available ranges are 60 sec in 1/100 ths, 60 min in 1/100 ths, and 60 min in seconds. Ratings include all standard voltages at 50 and 60 cps, 115 v, 400 cps (with d-c clutch) and various d-c voltages. Cramer Controls Corp., Centerbrook, Conn.

For more information—
Circle 83, inside back cover

Miniature Meter for Edge-Lighted Panels

A 1½ in. square panel meter, specifically designed for mounting on edge-lighted panels, is provided with an external shroud that permits mounting from the front of the panel with a minimum projection from the panel surface. The meter incorporates a special, miniaturized D'Arsonval movement said to combine small size and light weight with high sensitivity. Accuracy is held to ±3% of full scale deflection for d-c installations and ±5% for a-c. International Instruments Inc., P. O. Box 2954, New Haven 15, Conn.

For more information—
Circle 84, inside back cover

Right-Angle Gearmotor

Gearmotors, in 1 to 10 hp sizes for continuous-duty applications, and 1 to 30 hp for intermittent duty, are now available with horizontal or vertical mountings, conventional double shaft, and hollow shaft, said to fit all types of applications calling for reduced speeds.

A pair of helical gears are used

(Continued on page 295)

DOW CORNING CORPORATION

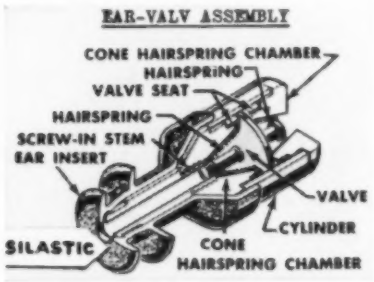
Silicone News

FOR DESIGN ENGINEERS No. 38

IMPROVE "SONIC EAR VALVE" WITH SILASTIC FITTINGS

Because SILASTIC®, the Dow Corning silicone rubber, is exceptionally resistant to sterilization temperatures and to natural body oils, the "sonic ear valve" developed by Sigma Engineering Company, Los Angeles, is now more hygienic, comfortable and longer lasting than ever before.

A protective device, the Sigma ear valve permits the user to hear ordinary conversation while minimizing the ear-splitting effect of loud noises. A complex yet durable unit, the valve consists of a tiny cylindrical mechanism containing several integral parts designed to function either individually or collectively. While each of the parts affords hearing protection, together they provide the utmost protection by dissipating the energy component of noise before it damages the eardrum.



Valve channels made from natural gum rubber were originally used, but the organic rubber had a relatively short service life and could not be sterilized. Sigma changed to SILASTIC fittings when tests proved the silicone rubber channels remain soft and comfortable for at least a year, and are easily sterilized in boiling water without reducing service life.

Sigma sells several thousand units monthly to Ordnance and Air Force personnel, industrial workers and to other occupational groups frequently exposed to loud noises. ®T. M. REG. U. S. PAT. OFF. *No. 386*

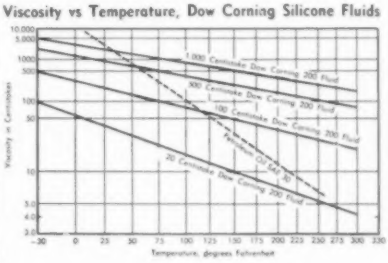
Dow Corning Silicone Lubricants, including oils and greases, are described in a new, illustrated 8-page brochure that gives their properties, lists typical applications, and cites factors which contribute to obtaining longer life.

SIMPLIFY DESIGN, REDUCE COSTS WITH SILICONE DAMPING FLUID

Practical application of Dow Corning 200 Fluid in a hydraulic system has enabled Truck Scale and Research Corporation, St. Petersburg, Florida, to simplify the design and sharply reduce the cost of their new "Quick-Way" truck scale.

This scale is unique in that it operates hydraulically rather than by conventional lever-balancing. Dow Corning 200 Fluid is used as the hydraulic medium because as the graph indicates, its viscosity changes very little from —40 to 400 F. The scale has only 8 parts, weighs a mere 350 pounds and sells for ⅓ the installed price of a conventional platform unit.

Viscosity vs Temperature, Dow Corning Silicone Fluids



The Quick-Way registers axle loads up to 30,000 pounds. Even with a slowly moving load it gives accurate, instantaneous readings on a dial which can be located as much as 50 feet from the scale.

Since Dow Corning 200 Fluid assures accurate readings during extremely hot and cold weather, no extra devices are required to compensate for temperature changes.

Exceptionally resistant to oxidation, the silicone fluid is sealed-in to assure long, reliable service life. About 30 cubic inches of 200 Fluid are used per scale. *No. 387*

For the latest news of silicones and to learn how silicones can help solve your design problems, be sure to visit BOOTH 406 at the Design Engineering Show.

1957 *Design Engineering Show*
New York Coliseum
May 20 to 23

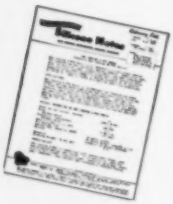
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



New Reference to Silicone Fluids describes the Dow Corning silicone fluids specified for most industrial and military applications. This convenient four-page reference lists typical applications, and physical and electrical properties for each fluid — from flash point to volume resistivity. A useful and compact data source designed to help you select the silicone fluid most suitable for any specific application. *No. 390*

Antifoam B, the lowest priced silicone foam-killer, has greater stability than any other water dilutable silicone defoamer commercially available. Antifoam B will not separate, oil out, settle or precipitate in most applications; retains uniformity and effectiveness even under adverse storage or operating conditions. Ready to use, it requires no diluting or pre-mixing. *No. 391*

Low Pressure Laminating with Silicone Resins is a concise "how-to-do-it" manual that describes methods of making structural and electrical laminates for high temperature service. Also includes after-curing schedules. *No. 392*

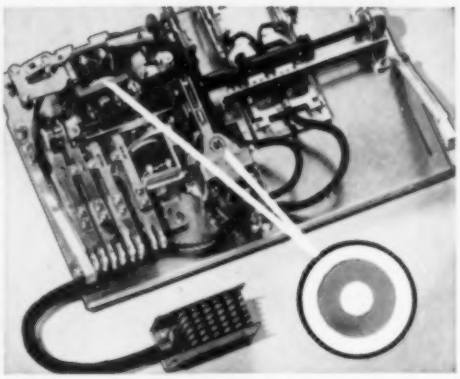
"The Effect of High Temperature on the Properties of Organic and Silicone Rubbers," reprinted from RUBBER AGE, contrasts the effects of heat and heat aging on ten types of rubbers, gives a good indication of their respective serviceability at various temperatures. *No. 393*

Parts and components made with Dow Corning Silicone Molding Compounds are lightweight, show excellent resistance to heat, and have good structural and electrical properties. Used as brush holders, collector rings, terminal boards, multiple lead connectors, heat dams for turbine driven alternator bearings, and aircraft brake shoe backing. *No. 394*

1957 Guide to Dow Corning Silicones is a twelve page, fact-filled reference describing the silicone products of interest to most industries. Containing latest data and information, the new 1957 Guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these versatile engineering materials. *No. 395*

SILICONE-GLASS LAMINATES—NEW SOLUTION TO HIGH TEMPERATURE INSULATING PROBLEMS

Faced with a need for electrical or electronic insulating parts that retain high physical and dielectric properties at elevated temperatures, more and more designers are specifying laminated glass parts bonded with Dow Corning silicone resins. Typical is Stromberg-Carlson's use of silicone-glass laminates for coil spacers and insulators in military field-type telephone switches.



While the cellulose acetate spacers previously employed proved durable enough under normal conditions, they didn't stand up in high temperature use. They failed quickly, for example, when continuing operation with faulty circuits sometimes raised coil temperatures to 320 C (680 F).

Stromberg-Carlson solved the problem once and for all by replacing the acetate spacers with single-ply silicone-glass laminates supplied by Mica Insulator Company.

According to Stromberg-Carlson engineers, the use of silicone bonded glass laminates has "increased the service life and dependability of the telephone switch." *No. 388*

Blind Workers Build Silicone Insulated Canned Motor-Pumps

While many manufacturers are making imaginative use of Dow Corning Silicones to improve product performance, other progressive companies are also using these versatile materials to simplify design and assembly. A striking example of this trend is provided by Nuclear Pump, Inc.

Nuclear has licensed the Philadelphia branch of the Pennsylvania Institute for the Blind to build silicone insulated canned motor-pumps ranging in capacity from 40 to 310 gpm. In addition to assembling the pumps, the blind workers also build the ½ to 10 hp silicone insulated motors which power the units.

The motor production and assembly operations performed by these workers include uncrating, weighing, stacking, riveting and grinding laminations, cutting and inserting slot insulation, winding and inserting coils, insulating top sticks, wrapping, connecting, dipping and baking.

The finished units, used primarily in the chemical and food industries, have only one moving part and can be disassembled in two minutes with a screw driver. An exceptionally low rejection rate highlights the fact that handicapped people are very capable workers, and proves again that electrical insulating components made with Dow Corning Silicones are easy to handle.

The reliability of the motors proves that silicone insulation is the most dependable motor protection money can buy. *No. 389*

Dow Corning Corporation, Dept. 8617, Midland, Michigan

Please send me: 386 387 388 389 390 391 392 393 394 395

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING MIDLAND

first in silicones

DOW CORNING SILICONES

CORPORATION MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C.

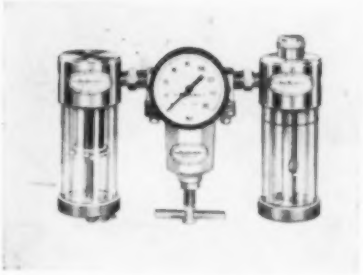
CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD. LONDON FRANCE: ST. GOBAIN, PARIS

for the primary reduction and a double-enveloping worm gear set for the secondary reduction. The double-enveloping feature of the worm gear set means that the worm shaft and gear wheel teeth are in constant double-throated contact over a 45° sector of the gear wheel.

The drive is supplied in a one-piece, finned housing. The footless motor, with D-flange and modified shaft is bolted directly to a flange cast integrally with the gear housing.

The gearmotors can be supplied with either an a-c or d-c motor of any speed or duty rating, and any standard type of enclosure, including protected-open, totally-enclosed, explosion proof. Reliance Electric & Mfg. Co., 24701 Euclid Ave., Cleveland 17, Ohio.

For more information—
Circle 85, inside back cover

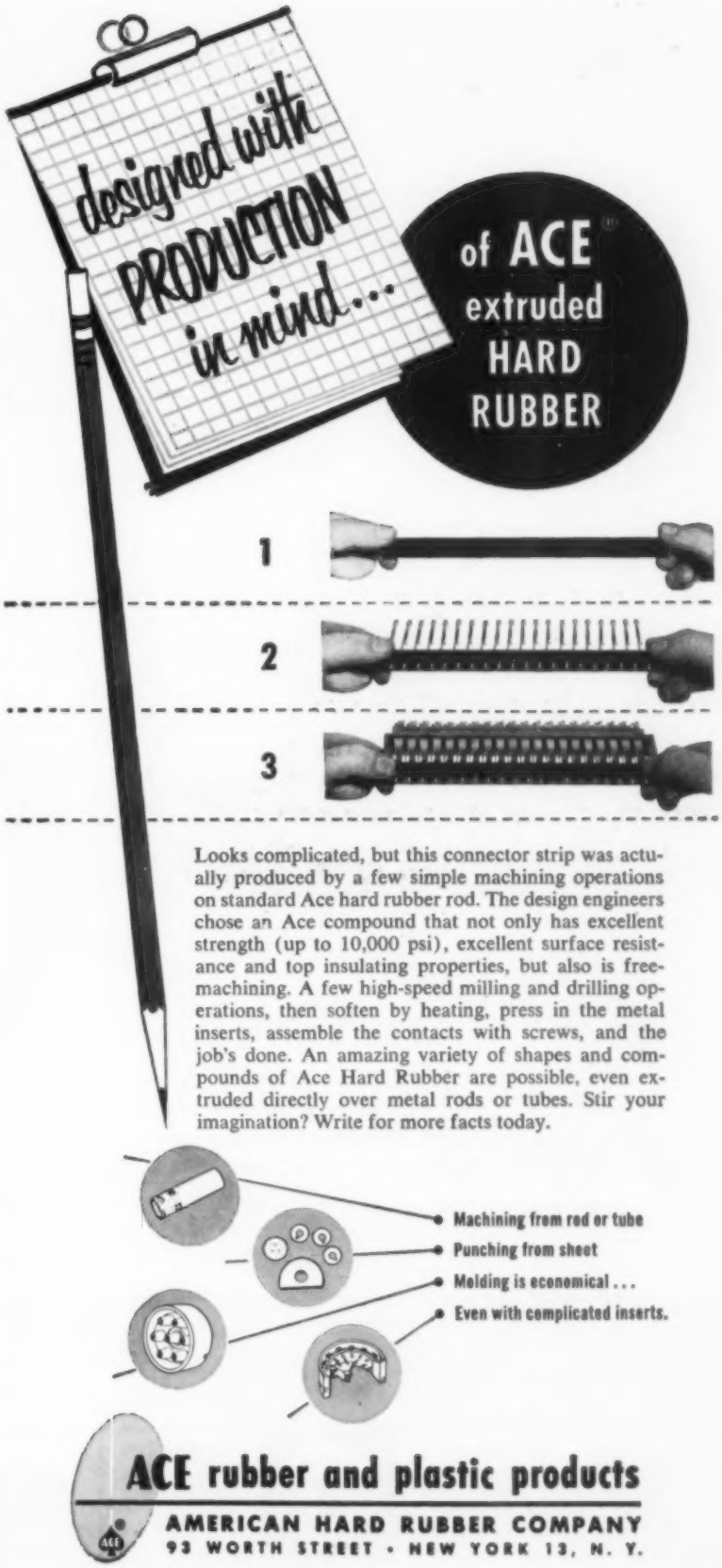


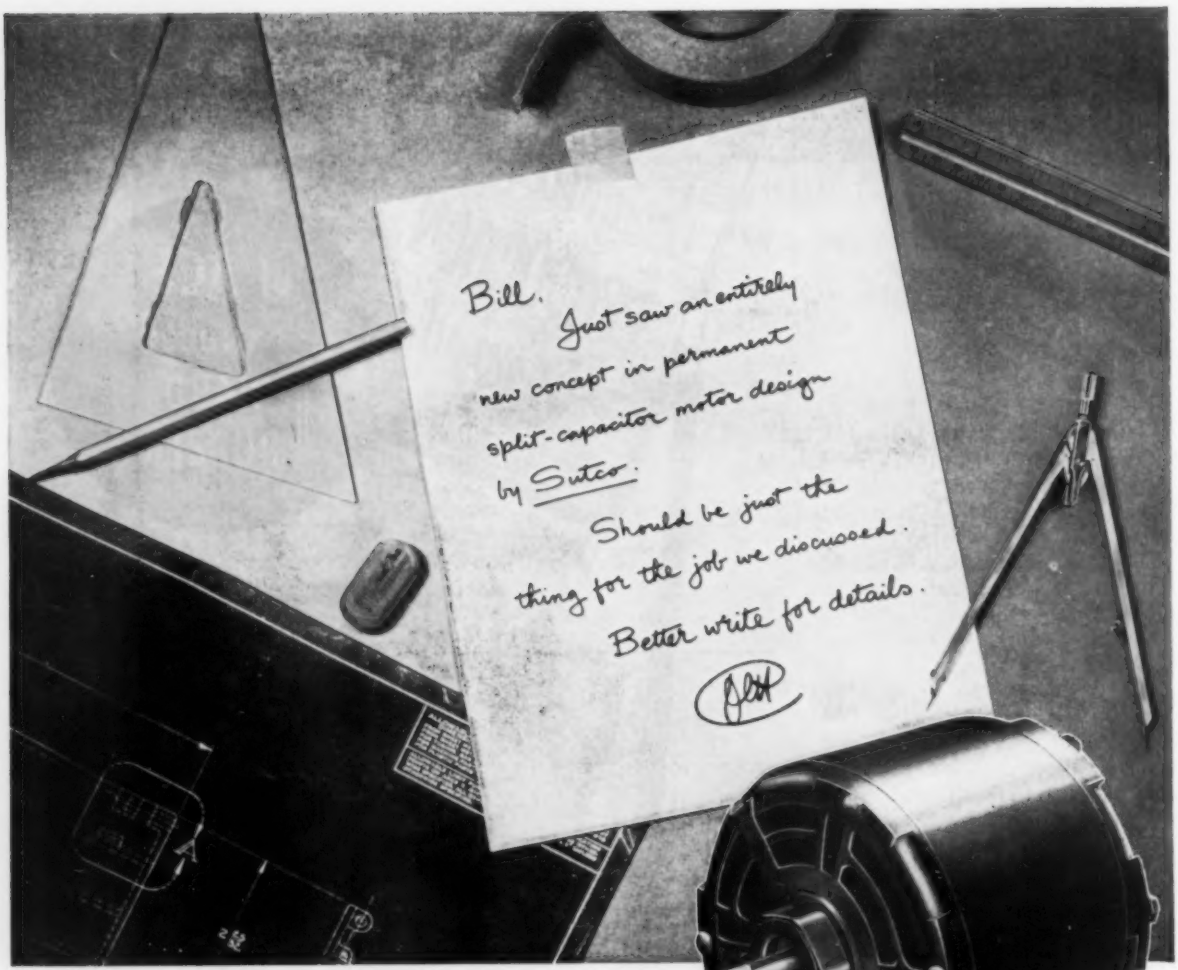
Air Line Filter-Lubricator

The twin baffle plates of the filter create centrifugal circulation of incoming air, forcing water and dirt particles to the base of the plastic reservoir. Any smaller dirt particles, still in the air stream, are then trapped by the 40 micron filter.

The lubricator, by air pressure and capillary action through a porous bronze wick, provides lubricated air, even during intermittent use. Oil-mist control gives control over the

(Continued on page 298)


designed with PRODUCTION in mind...
of ACE extruded HARD RUBBER
1
2
3
Looks complicated, but this connector strip was actually produced by a few simple machining operations on standard Ace hard rubber rod. The design engineers chose an Ace compound that not only has excellent strength (up to 10,000 psi), excellent surface resistance and top insulating properties, but also is free-machining. A few high-speed milling and drilling operations, then soften by heating, press in the metal inserts, assemble the contacts with screws, and the job's done. An amazing variety of shapes and compounds of Ace Hard Rubber are possible, even extruded directly over metal rods or tubes. Stir your imagination? Write for more facts today.
Machining from rod or tube
Punching from sheet
Molding is economical...
Even with complicated inserts.
ACE rubber and plastic products
AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.


Bill.
Just saw an entirely new concept in permanent split-capacitor motor design by Sutco.
Should be just the thing for the job we discussed.
Better write for details.

...and it will be 'just the thing for the job'–because...

6-Pole Type 6 C up to ⅓ H. P. 1050 R. P. M.

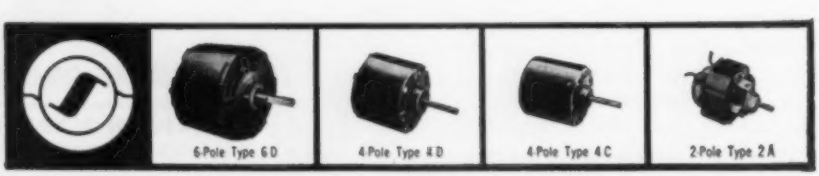
Sutco

Mini-Lap

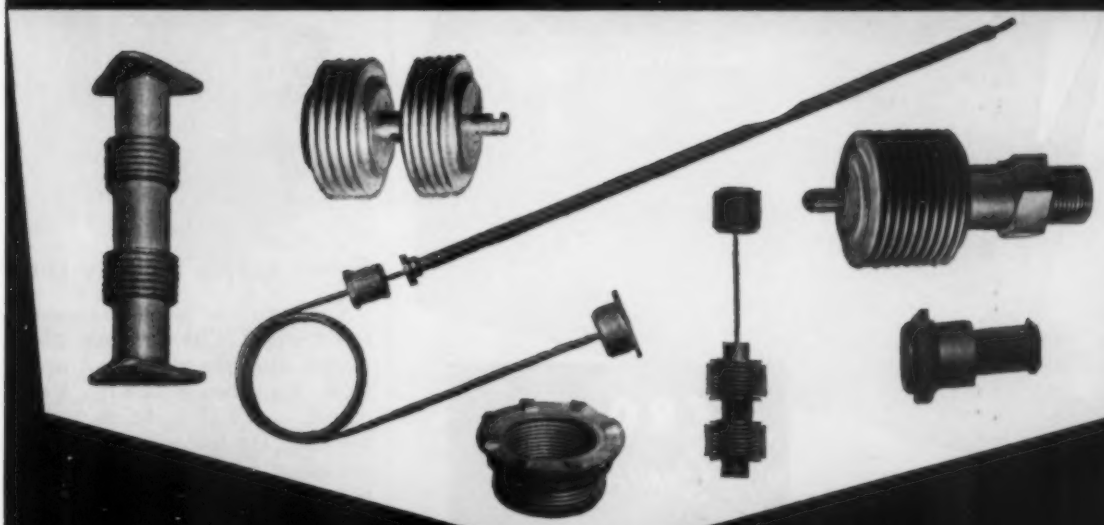
Sutco's new concept in a permanent split-capacitor motor – the *Mini-Lap** – sets new standards in competitively priced – low-cost – motors with ratings up to ⅓ H. P. Minimum overlap of expensive copper windings and fully automated winding of the stator reduces cost to YOU!... The unique design of the Mini-Lap motor allows cooler operation, higher efficiency and longer life for your products. Whatever your requirement in permanent split-capacitor or shaded-pole motors – check Sutco! Refer your needs to our competent sales and product engineers for the most economical solution to your problem.

*Patent Pending

Write to: SUTCO,
ORIGINAL EQUIPMENT DIVISION
The O. A. Sutton Corporation, Inc.
Wichita, Kansas



HOW TO SAVE TIME AND MONEY ON COMPLETE BELLOWS ASSEMBLIES



No matter why or how the bellows principle enters into an assembly, Fulton Sylphon can assemble the right bellows and related accessories or mountings into a complete device that meets your specifications. In doing this Fulton Sylphon offers important design help, specialized skill in joining bellows with other members, and modern production facilities for on-time deliveries.

BELLOWS FOR INSTRUMENT ASSEMBLIES

are available with diameters, lengths, strokes, spring rates, metals and charges to provide a wide range of movements in high or low pressure systems. In all applications the exclusive Sylphon® bellows assures continuing accuracy and safety of operation. For one thing, cold-working production methods give it maximum resiliency for withstanding repeated cycling. In addition, its *seamless* design and the availability of multiple plies enable the Sylphon bellows to better resist pressure and other conditions.

Send for Bellows Catalog JP—1400

Mr. Controls

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION, Knoxville 1, Tenn.

FULTON SYLPHON • BELLOWS HEADQUARTERS, U. S. A.

Have You A Design Problem Involving Switches?

ACRO SNAP ACTION micro-switches Can Meet Most Requirements

OFTEN REDUCE COSTS, TOO

Whether you're designing a new product or redesigning an existing one, chances are that the Acro switches can ease your path. You see, no other line of snap-action switches comes in so many standard types. Hence, you can, in all probability, profit from the important savings of being able to use a production line Acro switch for your special needs. Too, there may be the opportunity to improve your products' performance . . . to solve production bottlenecks . . . to lower costs. Why not find out today? Write us and one of our sales engineers will call.

Write for CATALOG

This 36-page switch catalog belongs in every design engineer's file. It gives operating characteristics, dimensions and other specifications for nearly 100 types of Acro switches. Write for your copy today.

The Biggest Line of Little Switches

Mr. Controls

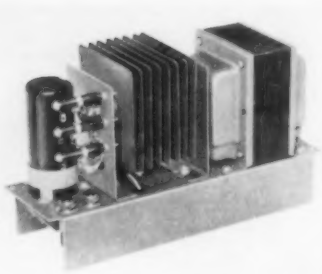
Robertshaw-Fulton
CONTROLS COMPANY
ACRO DIVISION
Columbus 16, Ohio

In Canada: Robertshaw-Fulton Controls (Canada) Ltd., Toronto

wick area exposed to the air stream.

Four port sizes, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in., are available for immediate delivery. Bellows Co., Akron 9, Ohio

For more information—
Circle 86, inside back cover



Power Supply for 28 v D-c

This magnetic amplifier-regulated power supply is for operating relays, motors, filaments and control equipment. Regulation of 28 v d-c, 5 amp output, is ±0.25 v d-c, no-load to full-load. For line voltage change of 105-125 v a-c (at 28 v d-c, 5 amp output), regulation is ±0.25 v d-c change in output. Ripple and internal noise are below 2.5 v a-c, rms.

The unit measures 12½ x 4 in. wide. Height above deck is 5 in., below deck, 2⅛ in. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

For more information—
Circle 87, inside back cover

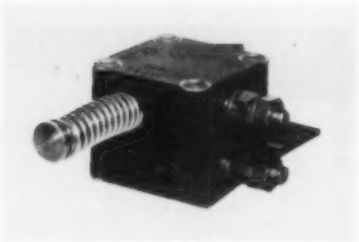
Vacuum-Tube Voltmeter

The instrument measures d-c (plus or minus) from 1 to 1000 v in seven ranges, a-c from 1 to 300 v (rms) in seven ranges, and resistance up to 500 megohm by means of seven multipliers. Accuracy of d-c voltage measurement is ±2% full scale; a-c volt-

(Continued on page 299)

age measurement, ±3% full scale. Frequency response is ±1 db from 10 cps to 700 mc. Imput impedance for d-c measurement is 100 megohms to minimize loading of the measured circuit. The instrument operates on 110-120 v, 60 cps, 20 w power. Acton Laboratories, Inc., Acton, Mass.

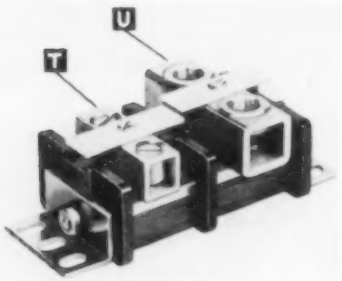
For more information—
Circle 88, inside back cover



Heavy Duty Limit Switch

This switch is normally closed (single-pole, single, throw), with double break action actuated by a 35 lb force. Instantaneous snap-action of the contacts occurs regardless of the speed of the actuating mechanism. The contacts open within ⅛ in. depression travel from the fully extended position. Tests and operation of over 20,000 cycles while interrupting 50 amp of current at 28 d-c gave no evidence of malfunction nor critical wear. Janco Corp., Burbank, Calif.

For more information—
Circle 89, inside back cover



Terminal Blocks for 125-250 Amp

Both of these types of terminal blocks are said to provide high-conductivity, high-pressure solderless connections. It is necessary only to strip the wires, insert and tighten the screws. The Type T block is rated 125 amp, 750 v to accommodate No. 6 to 1/0 wire AWG, and is

(Continued on page 300)

NEW BRIDGEPORT CAPSWITCH POSITION INDICATOR

for Aircraft and Missiles Systems

This highly sensitive device signals control board apparatus when a valve completes its opening and/or closing cycle. Thus malfunction of one or more valves in a fuel propellant system, for example, is instantly detected.

The new Capswitch position indicator is mechanically actuated by a sealed plunger that closes or opens control circuits when depressed or released by a complete cyclic movement of the valve stem.

Two small, lightweight models with the mechanism sealed in epoxy resins and encased in a steel shell. Model 65M41—SPDT type—weighs .095 lb.; model 65M83—DPDT type—weighs .19 lb. Both are made to close-tolerance specifications and are adaptable to any type of control where repeatability within ± .001" is wanted.

Bridgeport's new Capswitch Position Indicator can prevent costly errors and add appreciably to the safety factor in handling high-speed aircraft, missiles and rocket engines. Write for engineering bulletin No. JP-250.

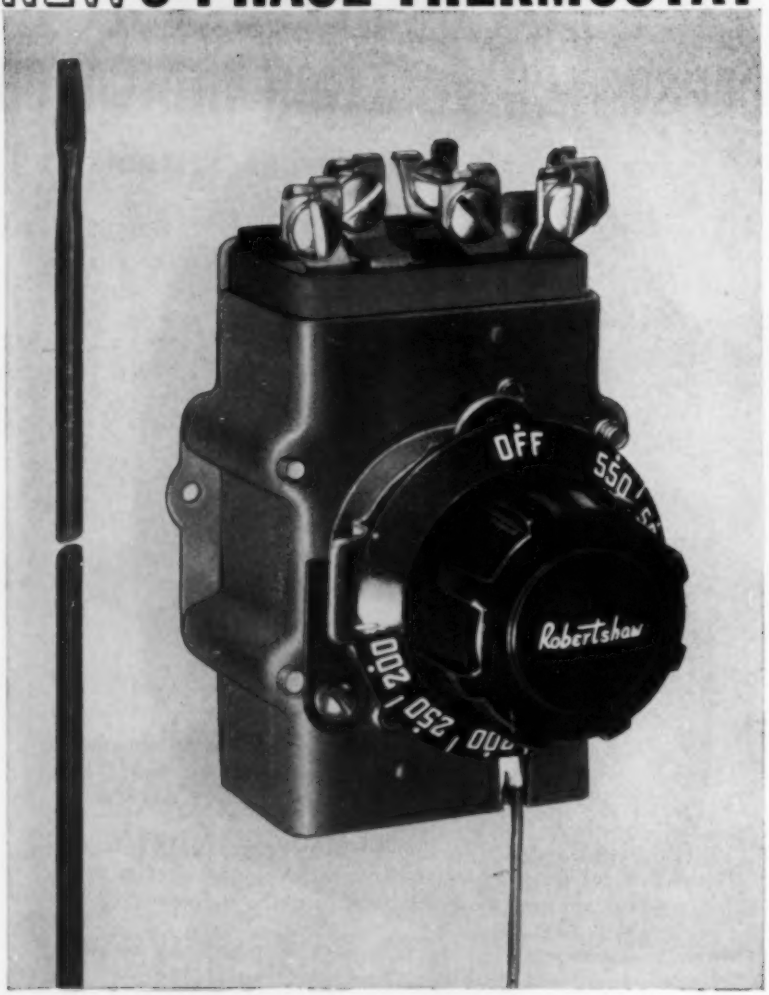
Bridgeport Thermostat Division also manufactures seamless metal bellows and bellows assemblies for aircraft control mechanisms. Literature available.

Mr. Controls®

Robertshaw-Fulton
CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION
MILFORD • CONNECTICUT

NEW 3-PHASE THERMOSTAT



Robertshaw® now offers the Model D-33 Electric Thermostat, a new and exclusive thermostat for 3-phase circuits on heavy duty electric ranges, sealing machines, and similar equipment. Available in various temperature ranges and dial markings. Can also be used in 2-phase systems where one phase is on during entire operation.

- extremely compact
- rugged—all steel
- ratings up to 25 amps., 250V, a-c

Robertshaw-Fulton CONTROLS COMPANY

Send for complete details

ROBERTSHAW THERMOSTAT DIVISION, YOUNGWOOD, PENNSYLVANIA

Robertshaw-Fulton Controls (Canada) Ltd., Toronto

available factory assembled with one to six terminals per block. Type U is rated 250 amp, 750 v for No. 4 to 250 MCM wire, AWG, factory assembled in blocks of one to four terminals. Curtis Development & Mfg. Co., 3250 N. 33 St., Milwaukee 16, Wis.

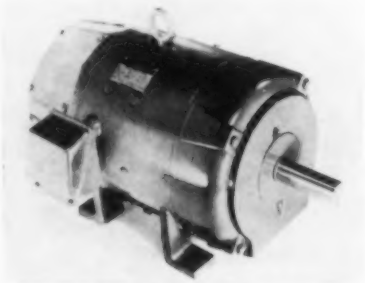
For more information—
Circle 90, inside back cover

Low-Level Digital Voltmeter

Rapid, accurate measurement of low-level d-c voltages from thermocouples, strain gages and transducers is said to be displayed numerically in this instrument's illuminated panel. It is available in either a rack mount or portable bench package.

The range is ±0.001 milliv to ±9.999 milliv, sensitivity of 3 to 5 microv and an accuracy of ±0.1% of full scale. Non-Linear Systems, Inc., Del Mar, Calif.

For more information—
Circle 91, inside back cover



D-c Motors and Generators

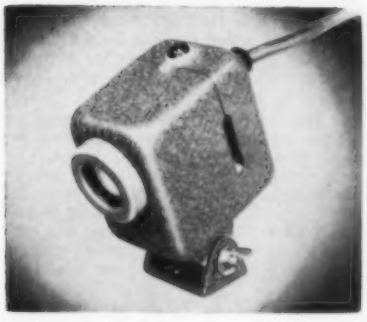
The motors and generators have dripproof enclosures and bear NEMA Class B ratings. They span motor ratings from 1 to 150 hp and generator ratings from ¾ to 100 kw.

Silicone insulation has been used, a controlled ventilation system draws

(Continued on page 301)

air from the drive end, distributes flow positively throughout the machine, and expels it at the commutator end. A new housing construction is said to permit the dripproof model to serve many applications which ordinarily require splashproof equipment. Armature inertia of the entire line is said to have been decreased, by as much as 55% in some ratings. Westinghouse Electric Corp., P. O. Box 2278, Pittsburgh 30, Pa.

For more information—
Circle 92, inside back cover



Photoelectric Light Projector

The projector has a lens system used in conjunction with a confined 4 cp filament lamp. The removable lens mounting ring allows light slit masks to be inserted.

A jeweled indicator serves as an effective warning in case of lamp failure. The self-contained series-limiting resistor provides lamp life expectancy of 1500 hr.

The unit measures 4.5 x 2.25 in. width. The projector is designed for 6.3 v a-c or d-c input. An identical projector operates on 12 v a-c or d-c. Autron Engineering, Inc., 1254 W. 6 St., Los Angeles 17, Calif.

For more information—
Circle 93, inside back cover

Miniature Rotary Selector Switch

These switches are rated at 50 ma, at 300 v a-c or d-c, and 500 ma, at 30 v a-c or d-c. All moving parts and the contact mechanism are totally enclosed, and the switch assembly is sealed for protection from dust and atmospheric conditions. Measures ¾ x ¾ in. deep including terminals.

(Continued on page 304)

WALKER-TURNER
FLEXIBLE SHAFT DIVISION

PROUDLY JOINS

Robertshaw-Fulton
CONTROLS COMPANY

Custom designed flexible shafting for:

AIRCRAFT APPLICATIONS
APPLIANCES
INDUSTRIAL MACHINES
RADIO AND ELECTRONICS
SPECIAL APPLICATIONS

Our new association with the Robertshaw-Fulton Controls Company offers many important advantages to users of high quality flexible shafting. Among them are greater field engineering representation, better service, a pooling of engineering and development talent and experience, and added prestige when you design Robertshaw-Fulton Flexible Shafting into your instruments and equipment.

We welcome your inquiries. Our engineers will work with you on new or known applications. Outline your design problem in a letter today . . . at no obligation.

Mr. Controls®

Robertshaw-Fulton
CONTROLS COMPANY

FLEXIBLE SHAFT DIVISION • 110 Summit Ave., Chatham, N.J.

GRC DIE CAST TINY PARTS HAVE MADE BIG CHANGES IN DESIGNERS' THINKING

Provide big opportunities for new designs, new products, new production economies.

Amazing design flexibility, made possible through Gries' unique die casting techniques, has made significant changes in designers' thinking.

They find that GRC has developed special, exclusive techniques which turn out simple or intricate parts, completely trimmed and ready for use, in *one automatic operation.*

The resulting economies, and the design latitude the Gries' method provide, open new horizons to designers in both product development and production economies. Frequently, manufacturing operations such as slots, square holes, flats on round surfaces are completely eliminated, and even multiple part assemblies can be produced automatically!

Parts are made to fit size, shape and tolerance specification *precisely*, and are mass-produced in quantities of 100,000 to many millions. *Smallness* is unlimited: Maximum weight, ½ oz., maximum length, 1¾ inches.

MODERN UP-TO-DATE GRIES PLANT OFFERS COMPLETE FACILITIES

The modern Gries plant in Westchester County, New York, provides large scale production facilities for small precision parts. It offers complete tooling and design equipment, as well as facilities for secondary operations such as tapping, drilling, assembling, reaming and special machining.

Practically all commercial finishes for zinc alloy die castings can be applied. Gries' many years of experience in finishing small die castings provides highest quality finishes at lowest cost.

GRIES OFFERS MANY OTHER PRODUCTS AND SERVICES

Gries can furnish many zinc alloy products directly from stock—including die cast industrial fasteners, and has facilities for the precision molding of tiny plastic parts. If you are interested in any of these other products and services, write direct for specific information.

See us at Booth **421**

Design Engineering Show

May 20-23, N. Y.

GRIES OFFERS FACT-FILLED INFORMATIVE DIE CASTING BULLETIN

Gries offers a factual bulletin containing charts of approximate dimensional and weight limits, comparisons of the GRC die casting method with other methods, composition and properties of zinc alloys for die castings as well as illustrations of many typical small parts and design engineers' guide for reference in designing products that use small parts.

WRITE, WIRE OR PHONE TODAY

for your copy of the Gries Die Casting Bulletin. Find out how Gries can help you solve your parts problems—economically and efficiently. Send prints for quotations.

GRIES STAFF OF ENGINEERS AVAILABLE FOR CONSULTATION

GRC maintains a staff of experienced engineers to aid manufacturers on all phases of design production. They will design production dies that best utilize the special machines and processes that have been developed by Gries over a period of 40 years. Gries engineers are available for consultation at any time.

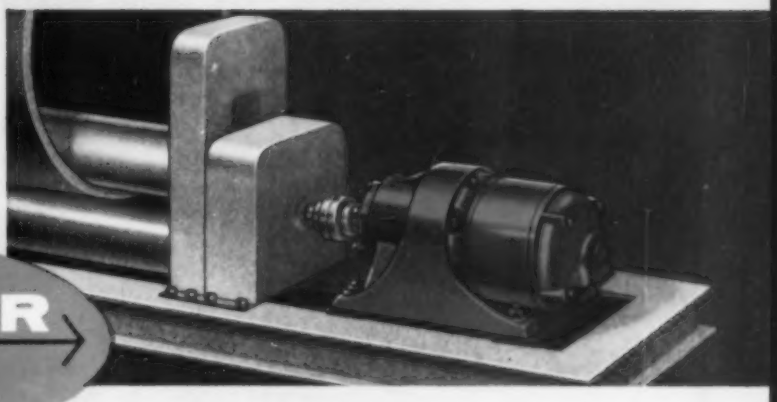
WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

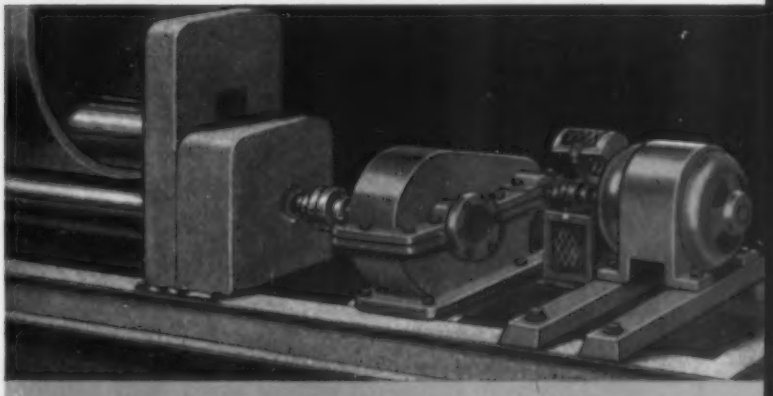
159 Beechwood Avenue, New Rochelle, N. Y. NEw Rochelle 3-8600

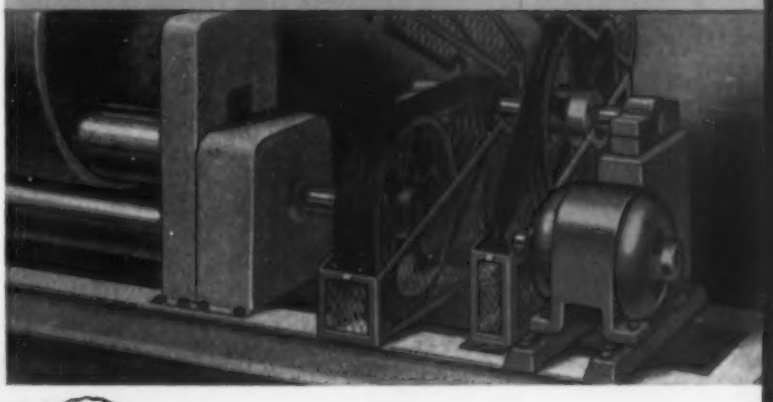
USE THE *Simplest* METHOD TO APPLY LOW SPEED POWER



SYNCROGEAR
THE INTERNALLY GEARED MOTOR

Reject CUMBERSOME HOOKUPS





The U. S. Syncrogear is more than a motor. Its "packaged" assembly includes a high speed motor, an enclosed sealed gear-train, correctly engineered for the load, always in exact alignment, all mounted in a single case which saves space and eliminates the ungainly appearance of complicated hookups. You don't have to calculate chain, sprocket, bearing or shaft requirements, or invest in separate mechanisms, special fabricated guards, extra pulleys and belting when you direct-connect a Syncrogear. More and more manufacturers are using Syncrogears on their products to improve appearance and increase saleability.

Free – Mail coupon for all new descriptive multicolor booklet with all the facts you should know about geared motors.

U.S. *Electrical* MOTORS

MAIL COUPON NOW

MOTORS

U. S. ELECTRICAL MOTORS Inc. PEN-7
P.O. Box 2058, Los Angeles 54, Calif., or Milford, Conn.
☐ *Send Syncrogear Booklet*

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____

WEST VIRGINIA SPECIAL SECTIONS
in this
Caterpillar®
No. 933
Traxcavator

Resulted in great savings — maintained highest quality standards for the Caterpillar Tractor Company.

Specially engineered sections saved high planing and machining labor costs. West Virginia engineering consultants helped develop a special rolled section produced to the rigid, high specifications required for any Caterpillar-built machine.

West Virginia Special Sections have saved time and money and assured ultimate strength in the products of many major companies. A West Virginia engineer may be able to help you with your production problems.

For free Engineering Consultant Service, call or write West Virginia Works, Connors Steel Division, H. K. Porter Co., Inc. at Huntington, West Virginia.

HKP CONNORS STEEL DIVISION
H. K. PORTER COMPANY, INC.

Available in single-pole, 12-positions, two-pole, 6-positions, three-pole, 4-positions, four-pole, 3-positions, and in either shorting or non-shorting contacts. Clarostat Mfg. Co., Inc., Dover, N. H.

For more information— Circle 94, inside back cover

Surface Temperature Transducer

This transducer is said to be accurate between at least −320F and 950F. It consists of a woven grid of fine platinum wire. It can be attached to any surface with a dielectric cement.

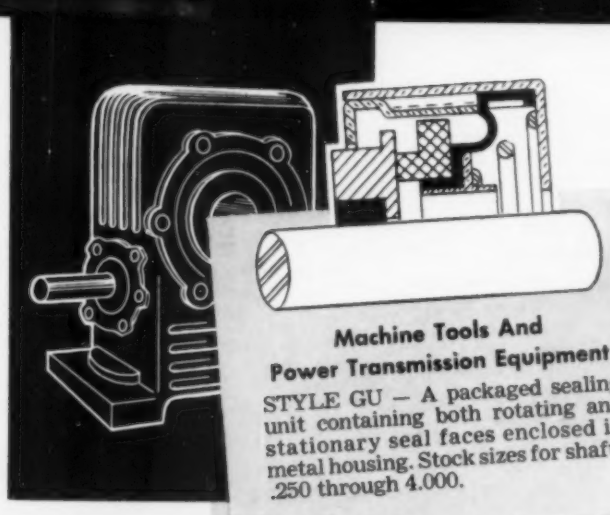
A 100-ohm change or more can be specified over an assigned temperature span from 100 to several hundred degrees. Charles Engelhard, Inc., 850 Passaic Ave., E. Newark, N. J.

For more information— Circle 95, inside back cover

Position Indicator and Controller

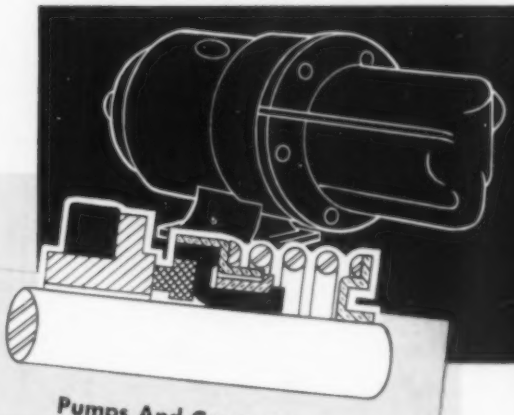
Operation and position indication of remotely located valves, gates, feeders, or other devices is possible with these units, which permit remote modulation and continuous indication. This is accomplished through the transmitter package (a plug-in unit) which has a three-position (open, close, and off) switch mounted on its face to control the device. Above this switch is a small voltmeter-type indicator graduated from 0 to 100% to

(Continued on page 308)



Machine Tools And Power Transmission Equipment

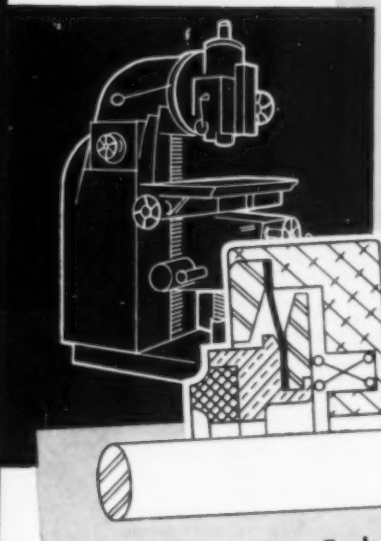
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

A Complete Line

GITS SHAFT SEALS

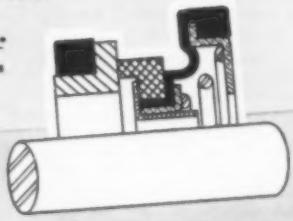
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

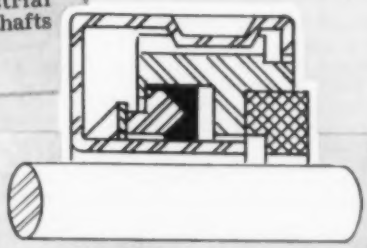
1638B South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



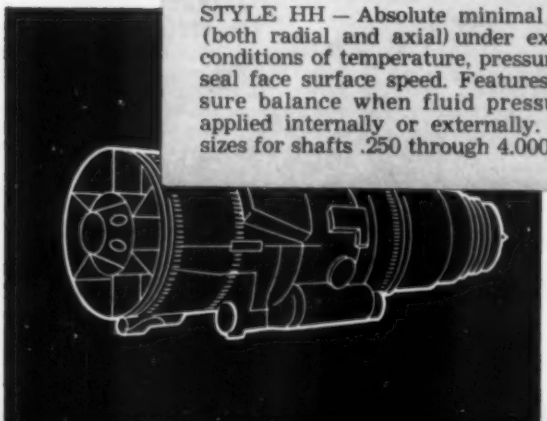
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: **BEARING FITS AND FITTING PRACTICES**

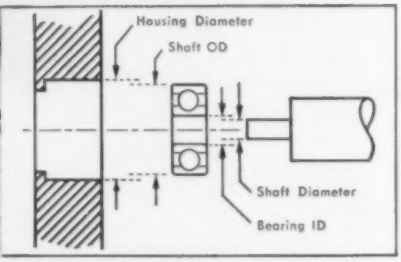


FIG. 1 ***Principle factors involved in fitting Micro-Bearings. Handling and fitting tools such as furnished by the Baker Co., Maplewood, Maine, enable operators to place or remove Micro-Bearings quickly, easily and help avoid damage.***

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the diameter of the shaft. Obviously, proper handling and fitting is an important factor in assembling the bearing to both shaft and housing.

Arriving at workable clearances is the subject of this bulletin.

RECOMMENDED FIT

In view of the absence of standards for shaft and housing fits in assembling instrument bearings, this data sheet is based on experience of users who are heavily involved in fitting problems. For example, the use of interference fitting *tighter than line to line* is not recommended for the majority of applications.

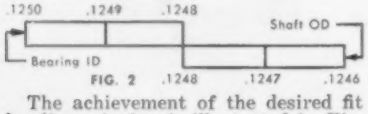


FIG. 2

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a 0.0002" tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0004" loose is shown.

An interference fit *not* tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum 0.0004" loose condition shown in *Fig. 1* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the *maximum* tight fit of line to line. The looseness may be reduced by redimensioning the shaft to 0.1249/0.1247 as

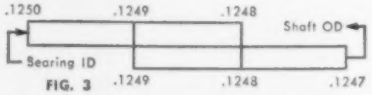


FIG. 3

shown in the block diagram, *Fig. 3*. If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve *cannot* be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes *must* be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *RMS surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications.

SIZING METHODS

Close tolerance fitting may be achieved by performing supplementary sizing operations on housings or shafts by the following methods:

"Bearingizing Tools" manufactured by the Cogsdill Tool Products, Inc., have been used on both housings and shafts, and potentially yield the greatest accuracy in the shortest period of time *(Fig. 4)*. A — Shaft sizing tool operates by peening oversize shafts to proper diameter. B — Internal Bearingizer enlarges housing holes to proper diameter.

"Ball sizing" has been used with a fair degree of success on through holes. This is essentially a swaging operation utilizing hardened steel or carbide balls.

While shafts may be polished by hand this is an expensive operation and may jeopardize good shaft geometry.

FIG. 4

CODING

Segregation of all parts into .0001 increments has been advanced by some bearing users as a solution to fitting problems. Upon request and for an additional cost, NHBB will code a given shipment to the following table.

DESCRIPTION	CODE	BORE TOLERANCE	O. D. TOLERANCE
LARGE BORE LARGE O. D.	11	+ .0000" − .0001"	+ .0000" − .0001"
LARGE BORE SMALL O. D.	12	+ .0000" − .0001"	− .0001" − .0002"
SMALL BORE LARGE O. D.	21	− .0001" − .0002"	+ .0000" − .0001"
SMALL BORE SMALL O. D.	22	− .0001" − .0002"	− .0001" − .0002"

Coding is not a general solution to the problem of fitting. Experience has shown that unless assembly techniques can cope with the existing distribution of bores and OD's within their .0002 spread, an unbalanced stock situation results in the user's plant.

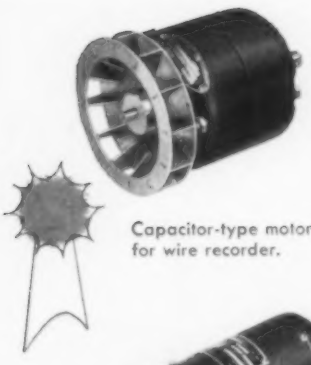
Manufacturing to closer boundary dimension tolerances is not recommended at the present state of the art. It is not usually feasible to mass produce bearings to a .0001 tolerance spread. It is generally necessary to produce some two to four times the quantity of parts desired to fulfill such requirements on the basis of selection from a standard .0002 tolerance. When a user of bearings relies solely on coding of parts, a procurement and stocking problem is eventually created.

Close collaboration between the bearing manufacturer and user is necessary in planning to meet fitting problems since neither one alone has access to complete knowledge or control over all the variables involved.

DESIGNERS HANDBOOK *OFFERED FREE* TO ENGINEERS

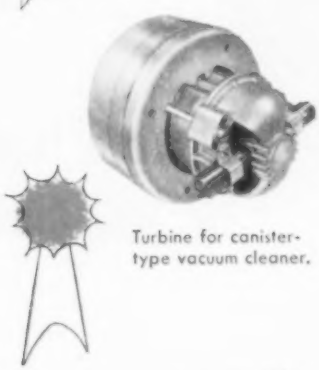
If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents. **Write to: New Hampshire Ball Bearings Inc., Peterborough 1, N. H.**



Capacitor-type motor for wire recorder.

Aircraft pressurizing pump motor.



Turbine for canister-type vacuum cleaner.

"Pocket-size" gear motor.

for your motor-driven products

Whether powering industrial, commercial or domestic products, Lamb Electric Motors have a record of exceptional performance.

Outstanding motor quality and uniformity are the results of our high degree of specialization in both equipment and methods, combined with rigid process control.

Your staff and ours working together can give *your* product the dependability and long life that result from this standard of motor quality . . . and frequently give you lower costs.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

If you are interested in any of the above motors write and we shall be glad to send full information.

Creative Papers from Mosinee

. . . are custom-tailored to specific needs . . . particularly yours

Making a tougher wrapping for packaging hard cash

BRANDT AUTOMATIC CASHIER CO. makes the paper wrappers for both coins and paper currency. While the job might seem simple enough, the paper from which the wrappings are cut and formed must have the right combination of qualities. It must have a good printing surface, be easy to glue and must have inherent strength to prevent both collapse when being filled and rupture if dropped.

MOSINEE created the sulphate paper needed . . . maintains uniformity of all desired characteristics within each run and from order to order.

To see how Mosinee may be able to help you get the correct papers for your product, processing or packaging, mail coupon.

Mosinee

MOSINEE
PAPER MILLS CO.
MOSINEE, WIS.

MOSINEE PAPER MILLS CO., Dept. PEN-5, Mosinee, Wisconsin
Please furnish details on how you can create special papers to meet our needs.

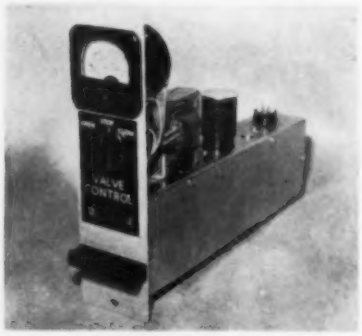
NAME..... TITLE.....

FIRM.....

CITY..... ZONE.... STATE.....

ADDRESS.....

PRODUCT.....

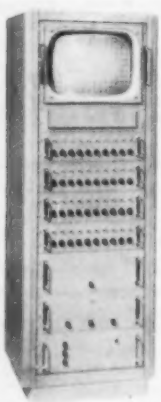


indicate the percent of opening.

At the receiving end, another packaged unit contains the control relays and the regulated d-c voltage supply used to transmit the position indication. A standard electric position transmitter is used to originate this voltage. Two wires and a ground are required for transmission of the signal. Builders-Providence, Inc., 345 Harris Ave., Povidence, R. I.

For more information—
Circle 96, inside back cover

ENGINEERING DEPT. EQUIPMENT



Oscilloscope Displays 40 Signals Simultaneously

An oscilloscope providing simultaneous display of 40 separate signals has a vertical bar graph, 9 x 12 in. consisting of 40 vertical lines. Line height is a linear function of signal amplitude and lines, regardless of height, are terminated with a marking dot at one end and at zero volts at the other for increased reading accu-

(Continued on page 312)

OVER-DESIGNING?

If you are designing bronze parts for mass production, there is a good chance that you are specifying a more costly alloy than you need.

ASARCO's patented continuous-casting process produces alloys according to SAE, ASTM and Government specifications. But their performance is entirely unlike that of similar alloys cast in sand or permanent molds. Relatively low-cost alloys cast by the ASARCO process perform like more expensive alloys cast by other methods.

For example, compare Continuous-Cast SAE 660 (ASARCON 773) with more expensive sand-cast alloys:

	Typical Yield Strength	Typical Impact Strength	Brinell Hardness
ASARCON 773	27,000 psi	12.5 ft.-lbs.	72
Sand-Cast SAE 62	20,000 psi	8.7 ft.-lbs.	65
Sand-Cast SAE 64	17,000 psi	8.2 ft.-lbs.	62

Unless you've checked to see whether the unique ASARCO bronzes can give you what you need, there's a possibility that you're over-designing. You may even be able to replace aluminum and manganese bronzes with low-cost ASARCON Continuous-Cast bronzes under certain conditions. Over-designing can be expensive in mass production, even if you are spending only a penny or two extra per pound of bronze.

ASARCON 773 (SAE 660) is readily available from stock in a wide range of sizes. An added bonus is the fact that ASARCON 773 is exceptionally free-machining. Rods, tubes, and numerous "extruded" shapes up to 9 inches in diameter are cast to order by ASARCO in more than 20 alloys.

We'll be happy to send you a free booklet describing the process and the product.

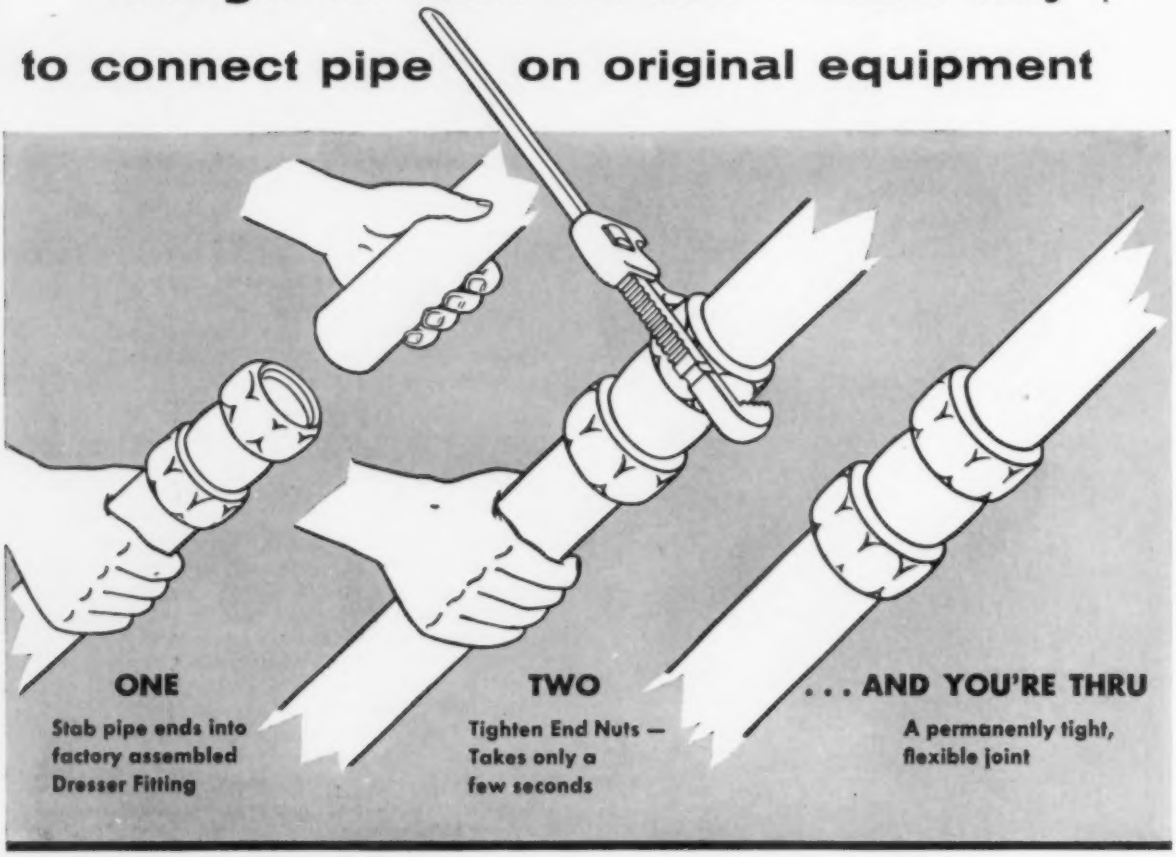
Continuous-Cast Products Department

AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana

WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

Designers: here's a fast . . . sure way to connect pipe on original equipment


ONE
Stab pipe ends into factory assembled Dresser Fitting
TWO
Tighten End Nuts — Takes only a few seconds
. . . AND YOU'RE THRU
A permanently tight, flexible joint

DRESSER flexible compression fittings

No threading . . . No complicated pipe fitting!

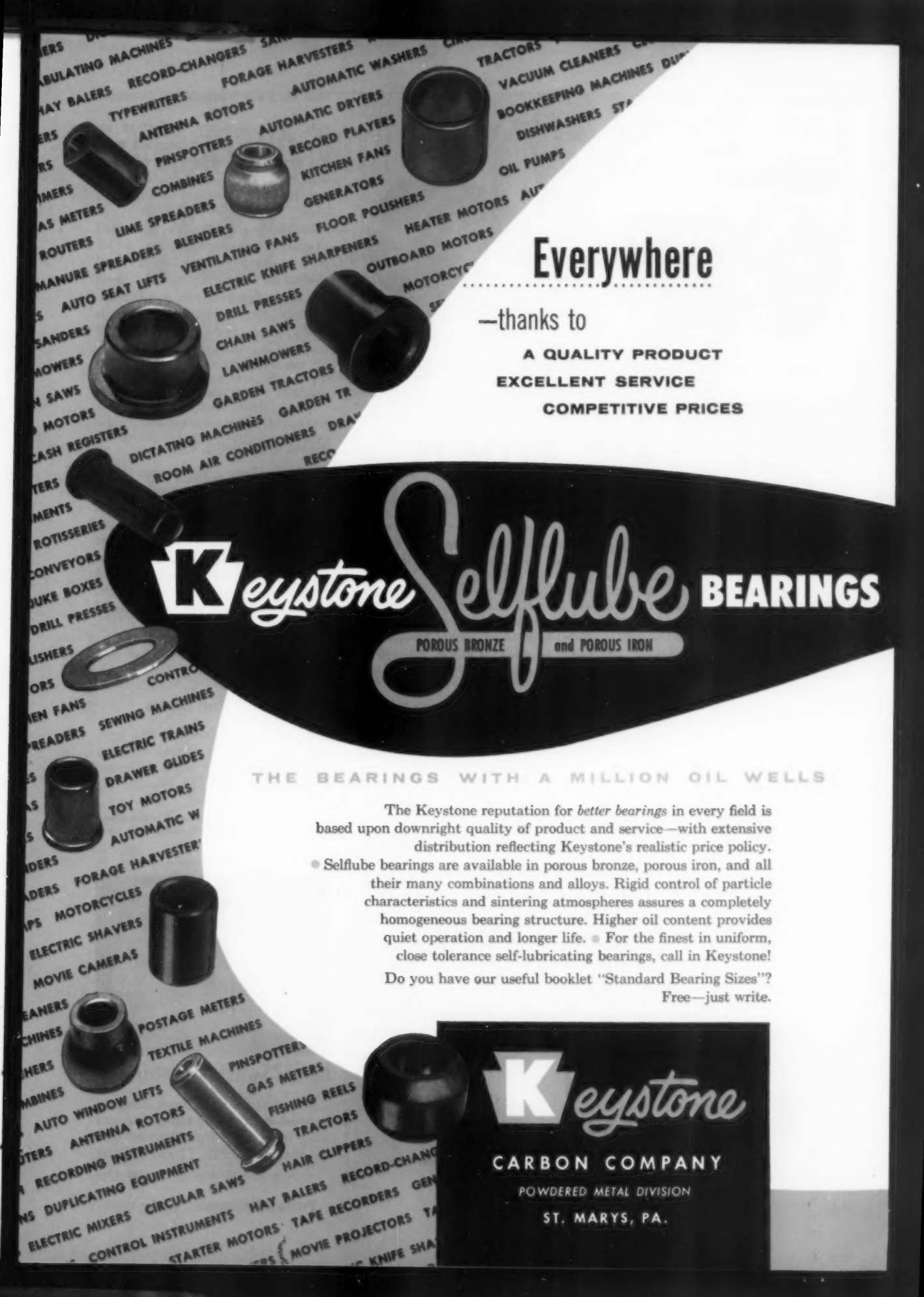
Every connection is permanently tight, leakproof, yet can be disassembled in seconds when equipment needs servicing. Only a wrench is needed.

Even if pipe ends are not in alignment, a tight joint is assured because of the resilience of the Dresser gasket. Dresser Fittings absorb vibration without leakage.

Dresser Couplings, Tees and Ells have been proved in years of service on all kinds of original equipment. Need additional information? Send now for new Catalog 505-R on original equipment applications.

DRESSER®

Dresser Manufacturing Division, Bradford, Pa.



Everywhere

—thanks to

A QUALITY PRODUCT
EXCELLENT SERVICE
COMPETITIVE PRICES

Keystone Selflube BEARINGS

POROUS BRONZE and POROUS IRON

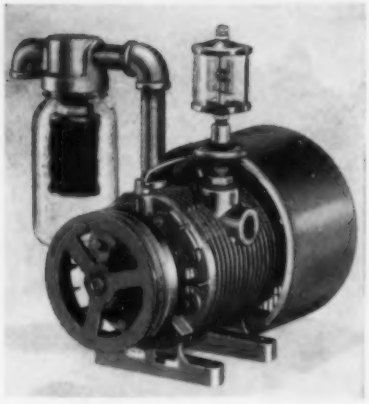
THE BEARINGS WITH A MILLION OIL WELLS

The Keystone reputation for *better bearings* in every field is based upon downright quality of product and service—with extensive distribution reflecting Keystone's realistic price policy. • Selflube bearings are available in porous bronze, porous iron, and all their many combinations and alloys. Rigid control of particle characteristics and sintering atmospheres assures a completely homogeneous bearing structure. Higher oil content provides quiet operation and longer life. • For the finest in uniform, close tolerance self-lubricating bearings, call in Keystone!

Do you have our useful booklet "Standard Bearing Sizes"? Free—just write.

Keystone
CARBON COMPANY
POWDERED METAL DIVISION
ST. MARYS, PA.

Compressor Model 4565-P3 to 20 p.s.i.



Vacuum Pump Model 4565-V6 to 25" hg.

Big NEW 45 c.f.m. fan-cooled Model 4565

GAST rotary vane AIR PUMPS—

Twice the capacity of previous models!

COMPRESSOR

Delivers to 45 c.f.m., to 20 p.s.i.g. continuously with 5 h.p. motor at 1750 r.p.m. At lower pressures, 3 h.p. may be used. Includes automatic lubricator, felt type intake filter.

●

VACUUM PUMP

Delivers to 45 c.f.m., vacuum to 25 in. hg. with 3 h.p., 1750 r.p.m. For 35 c.f.m. at 1350 r.p.m., 2 to 3 h.p. is adequate. Has heavy-duty lubricator and exhaust muffler.

●

WRITE TODAY for Bulletin 557-VP with performance data.

Here's new, bigger-volume air pump utility—for original equipment or plant use! Built for continuous, heavy-duty service as either a Compressor or Vacuum Pump, the Model 4565 eliminates water-cooling headaches. It's air-cooled by a 10" diameter pitch fan enclosed by cowl-guard which directs cooling air and insures safety by covering fan mounted on shaft extension.

Long-lived, efficient 5-vane rotary design delivers a positive displacement of pulseless air. No air tank is needed on compressor.

Pump is easy to mount. Drive with double v-belts eliminates precision alignment problems, and fan on pulley adds extra cooling capacity. Heavy ball bearings, with double row on drive end. Pump weight approximately 92 lbs.

Investigate Gast Model 4565—it may solve a problem for you! **Gast Manufacturing Corp.**, P.O. Box 117-V Benton Harbor, Michigan.

SUGGESTED APPLICATIONS

As volume source of low pressure air or vacuum, independent of plant air lines. COMPRESSOR: For air atomizing No. 5 or 6 fuel oil on burners for packaged boilers to 500 h.p., etc. VACUUM PUMP: Does the work of two smaller pumps for paper or sheet feeding to printing presses, packaging, labeling or bottle-filling machinery. Suitable for pipe-line milking machines, and for vacuum-forming large plastic sheets. Recommended for dry vacuum only.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

racy. This accuracy is further increased by use of a transparent overlay having 100 evenly spaced lines, with every tenth line of double width, and 40 vertical channel identification lines.

Sensitivity is 1:10 milliv. Individual channel attenuators provide a 3:1 or 5:1 change of gain or a small adjustment for compensating input line drop. Scanning rate is 400 channels per second. Input impedance is 5,000 ohms. Federal Telephone & Radio Co., 100 Kingsland Road, Clifton, N. J.

For more information—
Circle 97, inside back cover

Shaft Coupling Kit

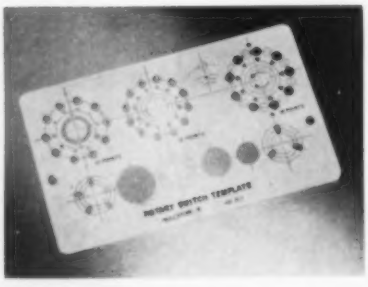
All couplings come assembled in a felt-lined case with associated hardware, such as hangers, shafts, clamps and tools. These are available for immediate delivery with shaft sizes of $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ in. Each kit contains nine couplings and 15 additional associated components. Pic Design Corp., Div. Benrus Watch Co., Inc., 477 Atlantic Ave., E. Rockaway, N. Y.

For more information—
Circle 98, inside back cover

Ruler Has Nine Scales

All scales are exposed to full view, each with its own slotted opening. The engineers' scale has nine scales. C-Thru Ruler Co., 827 Windsor St., Hartford, Conn.

For more information—
Circle 99, inside back cover



Rotary Switch Template

This template has been designed to assist in layout of wiring diagrams using rotary wafer-type switches. The template includes 10, 12 and 18-point

(Continued on page 316)

DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Industrial Service Division, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 24 STRENGTH AFTER FORMING

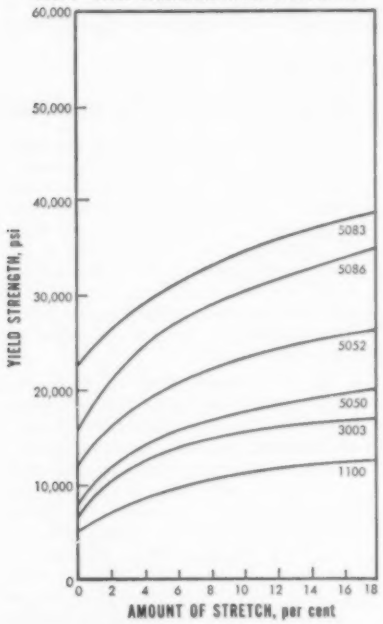
RATES OF GAIN IN YIELD AND TENSILE STRENGTHS VARY FOR DIFFERENT ALLOYS

(Note: This ad includes new and revised data from Product Design Ad. No. 5, "Strength After Working.")

THE increasing use of wrought aluminum alloys in load-carrying, formed parts has emphasized the need for quantitative data concerning the effects of forming operations on the mechanical properties of these alloys.

Such data are essential to design engineers. By taking advantage of forming effects, they can produce sound designs with greater economy by using less expensive alloys or thinner sections.

FIG. 1—YIELD STRENGTHS AFTER STRETCHING



The effects of plastic deformation during forming are especially important in the case of the non-heat treatable (or "common") alloys. The strengths of these alloys cannot be increased by heat treatment, but can be increased substantially by deformation.

The mechanical properties of all aluminum alloys are affected by plastic deformation. The extent of the effects vary from alloy to alloy, however. In general, yield strength and tensile strength increase with increasing deformation and for this reason the effects of deformation are referred to as "work hardening." Ductility is also affected by work hardening and, in general, is decreased by increasing deformation.

Effects of Stretching

Recent additions to the list of available non-heat treatable alloys have further extended the range of strength attainable in finished aluminum products. Alloys 5083 and 5086, developed by Kaiser Aluminum's Department of Metallurgical Research primarily for high strength welded construction, are finding many uses in high strength formed items.

This increased use of non-heat treatable alloys prompted the Kaiser research group to conduct tests which compared the new alloys with those already being widely used. The results of these tests provide data of paramount importance to engineers interested in the design and production of formed parts.

Tests were made on six alloys: 1100, 3003, 5050, 5052, 5083 and 5086. Commercial sheet material in the "O" temper and 0.064" thick was used, with the exception of alloy 5083. Here, the minimum commercial "O" temper plate thickness of 0.250" was used. All tests were made parallel to the direction of rolling. The test procedure was:

1. Stretch sample strips in tension by specified amounts.
2. Stabilize the strips using a thermal treatment of one hour at 300 F.
3. Cut two standard sheet tensile specimens from each strip.
4. Test the specimens to failure in tension.

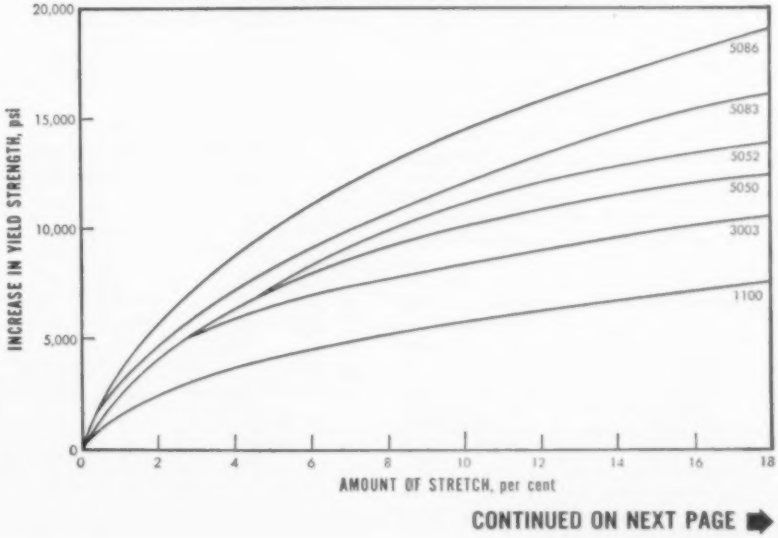
Alloys of the 5000 series containing Mg may show some changes in mechanical properties when held at the usual ambient temperatures for long periods of time after work hardening. In commercial materials such changes are frequently accomplished in a short time and a stabilized condition reached by suitable heat treatment. Such a stabilizing treatment was applied to all samples used in the present tests.

In general the changes consist of:

1. *A decrease in the yield and tensile strengths to stable values well above strengths of the same alloys in the "O" temper.*
2. *An increase in ductility of the work hardened materials.*

Ordinarily, the design of a stressed part should be based on the stabilized properties of an alloy or the properties retained after long periods at normal ambient temperatures. The manufactured part need not receive a stabilizing treatment, however, unless the resulting increase in ductility is considered essential for the application.

FIG. 2—INCREASES IN YIELD STRENGTHS CAUSED BY STRETCHING



CONTINUED ON NEXT PAGE ➡

What the Tests Show

Figs. 1 through 4 disclose the average results of these tests. Of primary interest to most designers is the yield strength of a material. The effect of stretching on the yield strengths of these alloys is shown in Figs. 1 and 2.

It is immediately apparent from Fig. 1 that the new alloys 5083 and 5086 are capable of yield strengths far higher than were formerly available in non-heat treatable wrought alloys. Alloy 5083 is particularly outstanding in this respect.

FIG. 3—ULTIMATE TENSILE STRENGTHS AFTER STRETCHING

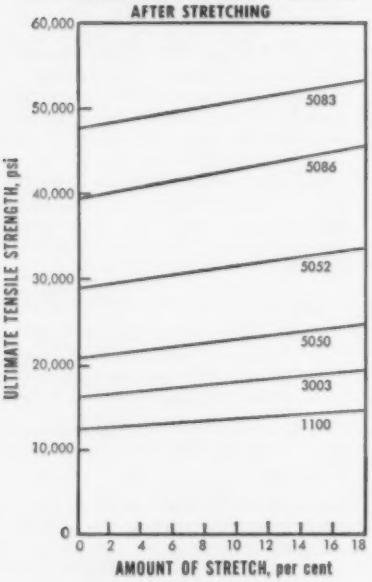
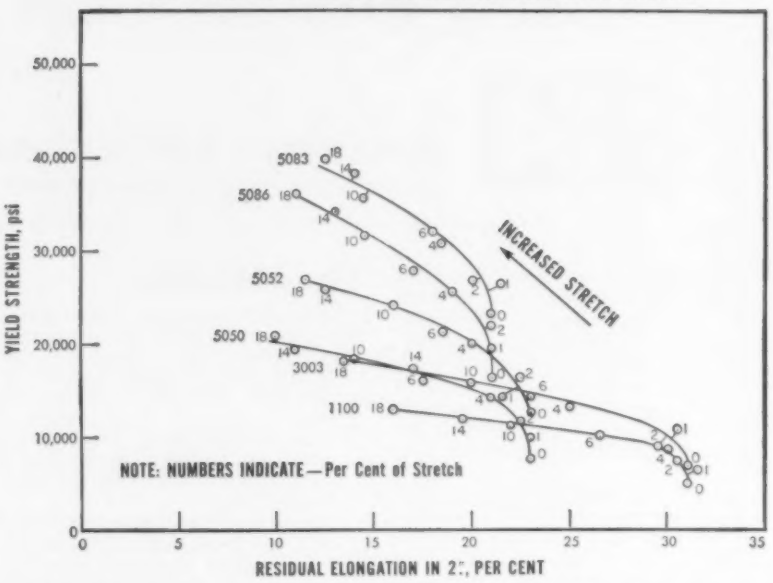


Fig. 2 shows the increase in the yield strengths of all six alloys caused by stretching. This figure demonstrates clearly that the higher yield strengths of 5083 and 5086 are due in large measure to their greater susceptibility to work hardening. The ability of 5086 to increase its yield strength through work hardening is outstanding.

Fig. 3 shows the effect of stretching on the tensile strength of these alloys. Although the tensile strengths are increased substantially by stretching, the increases are not so pronounced as in the case of the yield strengths. The new alloys 5083 and 5086 are shown in Fig. 3 to be far stronger than the previously available alloys.

Fig. 4 summarizes graphically the effects of stretching on the residual ductility and yield strengths of these alloys. This figure demonstrates that the large increases in yield strength caused by stretching may be obtained in combination with good residual ductility in all of the tested alloys. It also shows that the remarkably high yield and tensile strengths of 5083 and 5086 are obtained in conjunction with ductilities that are equal to the ductilities of the much weaker alloys 5050 and 5052.

FIG. 4—YIELD STRENGTHS AND RESIDUAL ELONGATIONS AFTER STRETCHING



Alloys Compared

To illustrate the interpretation of the data presented in Figs. 1 through 4, assume that:

1. The method of forming a part results in 10% stretch regardless of the thickness of the material used.
2. The formed part must be able to carry a load of 15,000 lbs. with a factor of safety of 2 with reference to yielding.

The table below compares the six lots of material tested using yield strength data taken from Fig. 1.

The remarkable strengths of the new alloys 5083 and 5086 are illustrated by the last column of this table. For conditions of tensile loading, this column shows that parts made from 5052, 5050, 3003 and 1100 must contain 31, 72, 100 and 173 per cent more material, respectively, than a part made from 5086.

Other Factors May Be Important

In selecting an alloy for a specific application, it is necessary that all relevant factors be taken into consideration. This includes such factors as the corrosive effects of environments in which the part may be used, the type of surface finish required and problems in connection with fabrication of the part. The performance of aluminum alloys with respect to each of these factors varies considerably.

Technical assistance in connection with aluminum alloy selection and fabrication may be obtained through the Kaiser Aluminum sales office or distributor listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California. Copies of a product information book on aluminum sheet and plate, containing comprehensive tables, may also be obtained on request.

Cross-Sectional Areas Required in Parts Stretch-Formed 10% in Order to Support a Tensile Load of 15,000 Pounds with a Factor of Safety of 2

Alloy	YS after 10% Strain, psi	½ of YS, psi	Area Required in Stretched Part, sq. in.
5083	34,000	17,000	0.89
5086	30,000	15,000	1.00
5052	23,000	11,500	1.31
5050	17,500	8,750	1.72
3003	15,000	7,500	2.00
1100	11,000	5,500	2.73

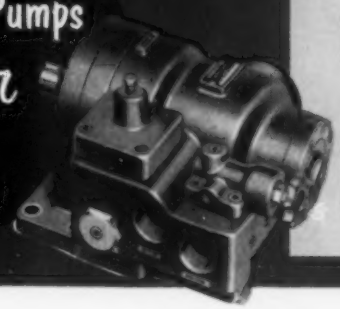
see our catalog in
PRODUCT DESIGN FILE
or write for copy

Kaiser Aluminum
setting the pace—in growth, quality and service

Do You Want To Save Horsepower and Heat?

VICKERS®

Two-Pressure Oil Hydraulic Pumps Require Less Power for Two-Pressure Circuits



Automatically Provide

High Volume @ Low Pressure for fast closing, rapid advance, and rapid return.

•

Low Volume @ High Pressure for feeding, compressing, clamping, and holding.

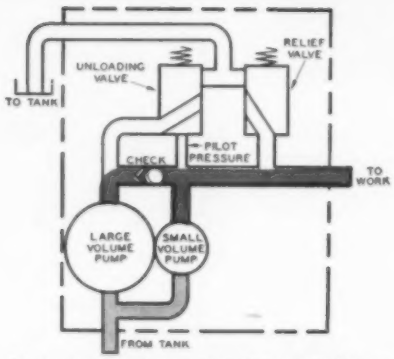


Fig. 1 Combined Delivery of Large and Small Volume Cartridges at Low Pressure

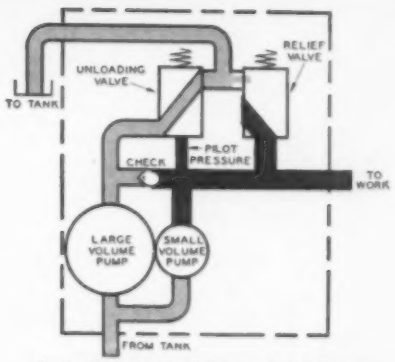


Fig. 2 Delivering Small Volume at High Pressure

Two Vickers Vane Type pumping cartridges are mounted on the same shaft—in the same housing, driven by the same prime mover. One provides a large volume of oil while the other delivers a small volume. These Vickers Two-Pressure Pumps have proved advantageous in a wide variety of applications.

For example, in closing a press or in rapid advance, both pump cartridges work together, supplying maximum volume for quick operation (see Fig. 1). When the press is closed and compression begins, or when the tool goes into feed immediately prior to beginning the cut, the large volume cartridge is automatically unloaded to the reservoir at zero pressure (see Fig. 2). The small volume cartridge alone then provides the lower volume required at high pressure.

These Vickers Two-Pressure Pumps are most economical in power consumption for such two-pressure operation. The reason for this is that a small-volume pump working at full capacity is MORE EFFICIENT than a large-volume pump working at partial capacity. Regardless of momentary delivery, the internal leakage of any pump is proportional to its size and operating pressure. The chart (Fig. 3) shows an interesting comparison between a Vickers Two-Pressure (Two-Volume) Pump and a variable volume vane type pump on a press circuit.

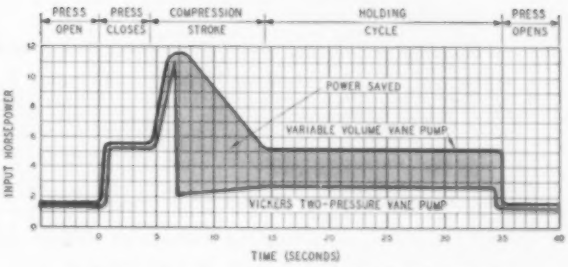


Fig. 3. On this typical press application the saving in power is approximately 50% with a resultant saving in heat in the system.

Like all Vickers Vane Pumps, these two-pressure pumps have the hydraulic balance feature that relieves bearings of all pressure loads (one of the major causes of wear). Cartridge construction enables customer to service in his own plant instead of returning to factory should repairs be necessary. Relief and unloading valves are integral . . . minimizing piping and connections. Complete range of sizes up to 48 gpm. For additional information, ask for Bulletin 54-70a.

6895

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
MACHINERY HYDRAULICS DIVISION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1454 • Detroit 32, Michigan

Application Engineering Offices: • ATLANTA • CHICAGO CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA WASHINGTON • WORCESTER
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

NEW CALIDYNE 177 SHAKER SYSTEMS

The Model 177 is one of a new series of "wide-band" shakers designed for higher frequency operation and lower input requirements. It is the Basic Unit for five completely integrated CALIDYNE Vibration Test Systems. Oscillatory linear forces up to 5000 lbs. are generated and precisely controlled over wide ranges for vibration research and test of products up to 411 lbs. maximum load. Any of these five Vibration Test Systems using this New Model CALIDYNE 177 Shaker will enable you to:

1. Discover effects of "brute force" shaking on your assemblies and determine their ability to withstand vibrations far beyond those of normal operation.
2. Provide factual vibration data essential in determining mode shape, frequency and damping characteristics.
3. Determine results of fatigue testing at extremely high stresses and deflections.

CALIDYNE VIBRATION TEST SYSTEMS USING NEW MODEL 177 SHAKER

System Number		Type of Vibration	Force Output	Power Supply	Frequency Range	Maximum Load	
						10 g.	20 g.
1	177/80	Sinusoidal	3500 lbs.	Electronic	5-2500 cps.	261 lbs.	86 lbs.
2	177/180	Sinusoidal	5000 lbs.	Rotary	5-2000 cps.	411 lbs.	161 lbs.
3	177/186	Sinusoidal	5000 lbs.	Electronic	5-2500 cps.	411 lbs.	161 lbs.
4	177/190	Random or Sinusoidal†	5000 lbs.	Electronic	5-2500 cps.	411 lbs.	161 lbs.
5	177/190	Random†	5000 lbs.	Electronic	5-2500 cps.	411 lbs.	161 lbs.

†*This system will perform with Random, Sinusoidal, Tape or Mixed Inputs.*

A separate Bulletin 17700 details the specifications, performance data, basic components and accessories of the new Model 177 CALIDYNE Shaker and its five Shaker Systems. For engineering counsel in applying Controlled Vibration to your research and testing, call us here at CALIDYNE — WInchester (Boston) 6-3810.

THE CALIDYNE COMPANY

120 CROSS STREET, WINCHESTER, MASSACHUSETTS

SALES REPRESENTATIVES

Technical Instruments, Inc. Waltham, Mass. (Twinbrook 3-1400) Syracuse, N. Y. (Syracuse 3-7870)

G. Curtis Bagel & Associates Ridgewood, N. J. (Gilbert 4-1400) Syosset, L. I., N. Y. (Walnut 1-5095) Philadelphia, Pa. (Walnut 2-2270)

M. P. Odell Company Westlake, Ohio (Trinity 1-8000) Dayton, Ohio (Oregon 4441)

Pittsburgh, Pa. (Fremont 1-1231) Detroit, Michigan (Broadway 3-5399)

P. O. Jodon, Inc. Washington, D. C. (Oliver 2-6406)

Specialized Equipment Corp. Cocoa Beach, Fla. (Cocoa Beach 3328)

Hugh Moreland and Co. Chicago, Ill. (Ashsecedor 2-1555) Indianapolis, Ind. (Glendale 3803) Minneapolis, Minn. (Colfax 7949)

Gerald B. Miller Co. Hollywood, Calif. (Hollywood 2-1195) San Diego, Calif. (Academy 2-1121) Belmont, Calif. (Lytel 1-0365)

John A. Grosa Co. Dallas, Texas (Riverside 1-3266) Houston, Texas (Jackson 6-2950) Tulsa, Oklahoma (Riverside 2-4657) Tucson, Arizona (East 6-1266) Denver, Colorado (Acoma 2-9276)

Albuquerque, New Mexico (Albuquerque 5-8606) Seattle, Wash. (Lander 3320) CANADA

Measurement Engineering Ltd. Arnprior, Ont. (Phone 400) Burlington, Ont. (Mohawk 4-5686)

EXPORT

Rocke International Corp. 13 East 40th Street, N. Y. 16, N. Y. (Murray Hill 9-0200)

rotary switches, and can be used in other combinations by utilizing the center holes as a rotating point.

Made of 0.030 in. mathematical quality plastic. Size of template is 6⅜ x 3⅞ in. Rapidesign, Inc., Box 592, Glendale, Calif.

For more information—
Circle 100, inside back cover

Portable 3-in. Oscilloscope

Designed for field use or rack mounting, this oscilloscope weighs 27 lb and measures 5 x 19 x 11⅛ in. deep. The portable instrument offers a sensitivity of 22 milliv per in d-c. Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.

For more information—
Circle 101, inside back cover

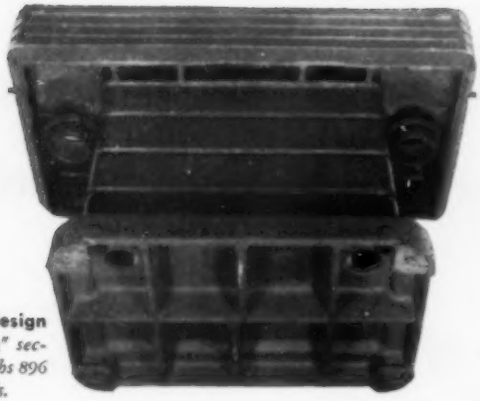
Wide-band Oscilloscope

Range of this instrument is from d-c to beyond 50 megacycles. Building block design allows interchanging of units for choice of performance characteristics and for forming various systems. Six interchangeable units, modular in effect, are housed in two identical cabinets mounted on a dolly. Each unit is designed for immediate insertion in a 19-in. rack, if desired.

Precision calibrated sweeps range from 0.02 sec/cm to 0.01 usec/cm, in 20 variable steps. Pulse rise time is 7 milli-microsec. A built-in attenuator provides sensitivity ranges from 0.2 to 200 v full scale.

The six interchangeable units include an indicator, Y-amplifier, and

(Continued on page 320)



Original design *requires ½" sections, weighs 896 pounds.*

Present welded steel design *uses ¼" sections, weighs only 446 pounds.*

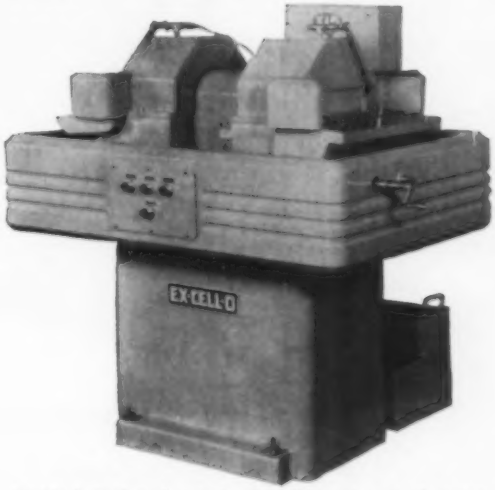
DESIGNED FOR GREATER RIGIDITY

. . . welded steel makes it better—at lower cost

THIS machine tool base was once a casting, but is now fabricated by welding. The result . . . still higher quality, more rigid machine.

Because of steel's greater strength, the required rigidity is attained with half the weight of casting. Manufacture is simplified, pattern expense is eliminated, lowering production costs.

These benefits can be duplicated on many types of machine components similar to your own through proper design for welded steel. A Lincoln specialist will gladly show you how.



Welded steel *tool grinder for sharpening single point tools of carbide, cast alloys and high speed steels. Photo courtesy Ex-Cell-O Corporation, Detroit, Michigan.*

THE LINCOLN ELECTRIC COMPANY

Dept. 1322, Cleveland 17, Ohio

Creating lower costs for industry . . . with welded design

When steel is 3 times stronger than iron . . .

Has two and one-half times the rigidity . . .

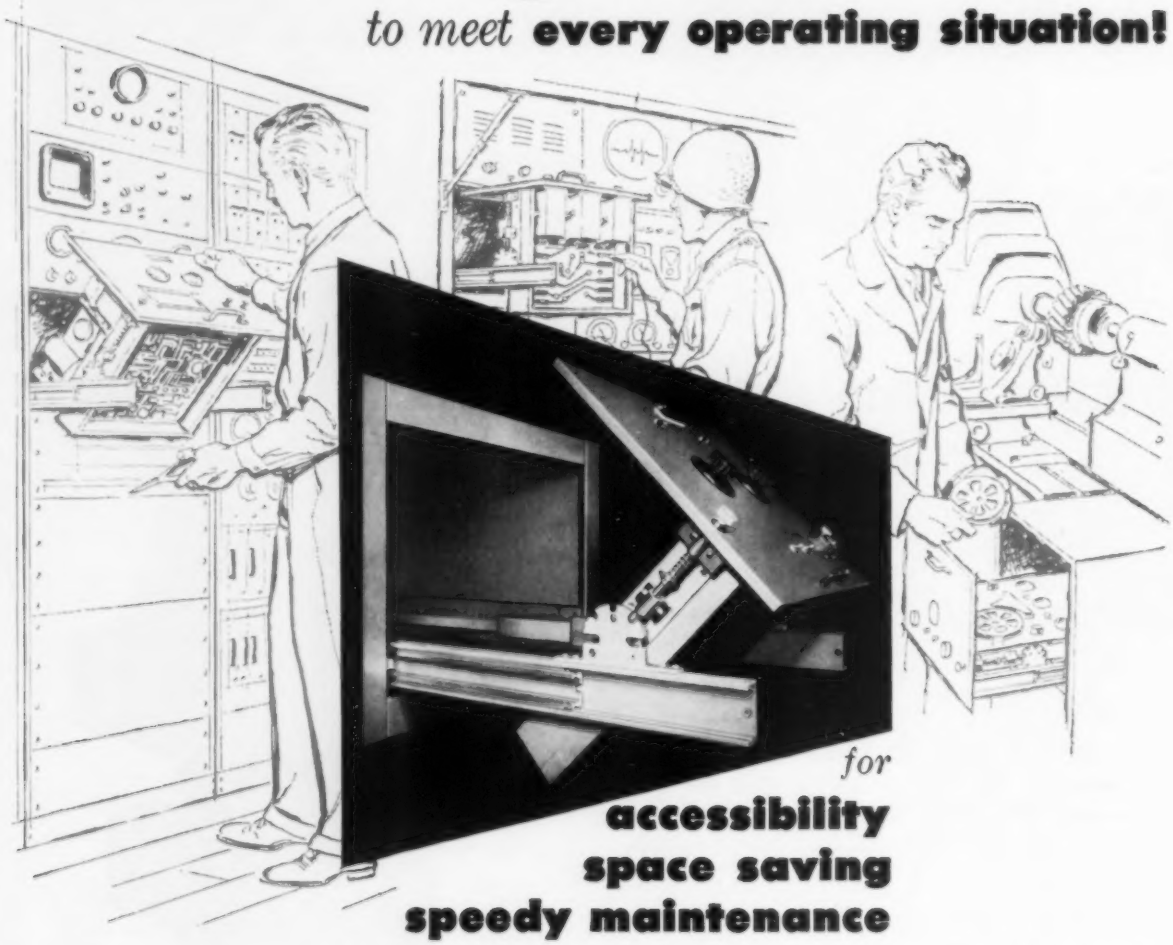
Yet costs a third as much per pound . . .

WHY

aren't your products designed for welded steel.

over **100** *designs of* **Grant INDUSTRIAL SLIDES**

to meet **every operating situation!**



for

accessibility
space saving
speedy maintenance

Grant Industrial Slides afford substantial, practical mountings for nearly all types of assemblies—electronic, hydraulic, pneumatic, mechanical. They allow quick access...the pivoting types permit testing or work on underside as well as top of chassis...also provide for quick release of chassis for bench servicing. Slide mounting usually eliminates need for rear access doors and rear aisles—a very important saving of space. Grant slides are soundly engineered, durable and dependable. Load capacities range up to 500 lbs. and more.

Grant engineers and representatives in all important industrial areas offer specialized experience—will aid in working out custom variations to adapt standard slides to especially exacting requirements.

Ask For This Important Working Data

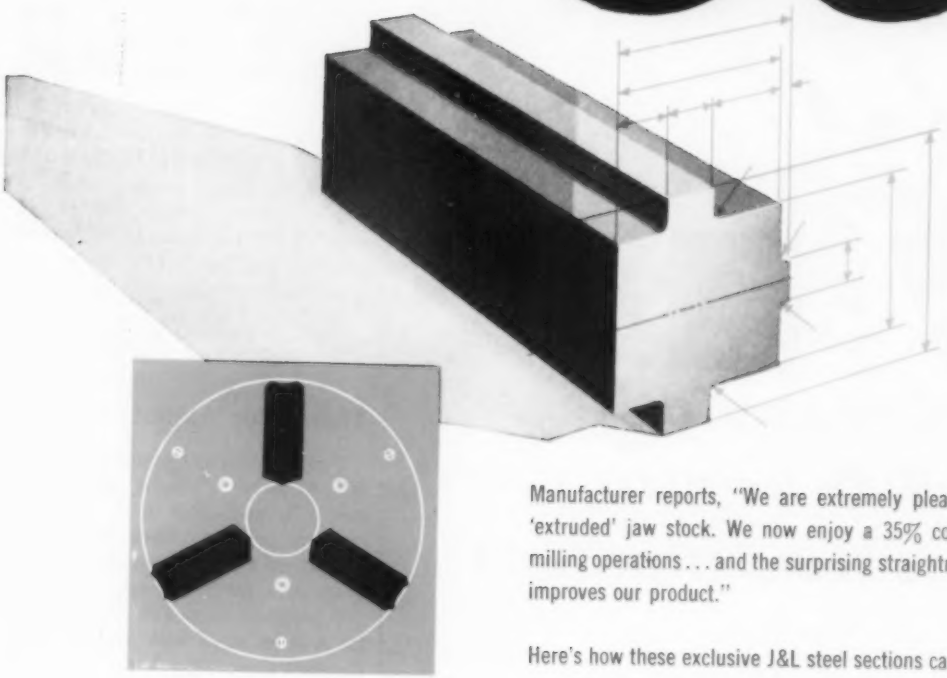
The Grant Industrial Slide Catalogue is a working manual on built-in accessibility. Ask us to mail your free copy.

Grant INDUSTRIAL SLIDES

Grant Pulley and Hardware Corporation
31-77 Whitestone Parkway, Flushing 54, N.Y.
944 Long Beach Avenue, Los Angeles 21, Calif.

J&L hot extruded, cold drawn chuck jaw section reduced milling cost

35%



Manufacturer reports, "We are extremely pleased with this purchased 'extruded' jaw stock. We now enjoy a 35% cost reduction on our jaw milling operations . . . and the surprising straightness of the extruded bars improves our product."

Here's how these exclusive J&L steel sections can reduce your costs:

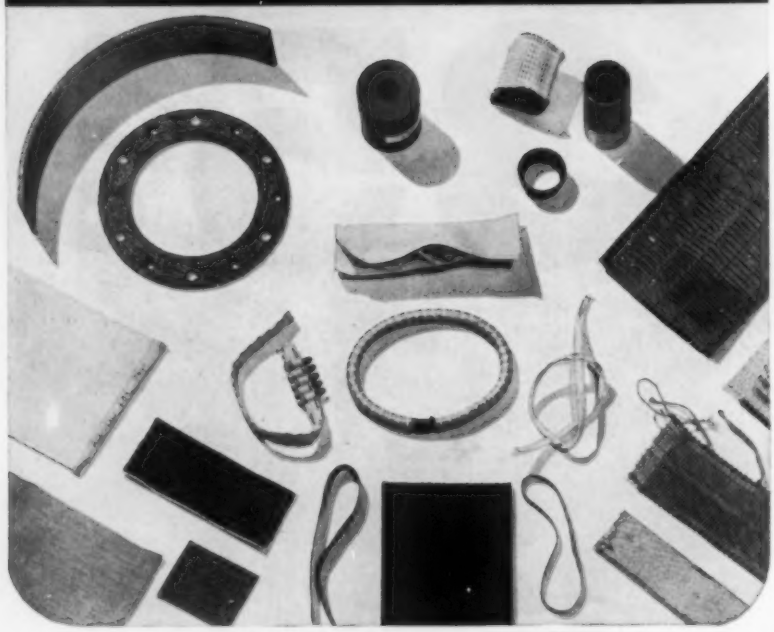
1. Eliminate machining and finishing operations.
2. Reduce scrap losses almost to zero.
3. Eliminate cost of casting and forging intricate sections.
4. Reduce inventories because extrusions are quickly available.

Investigate this new production technique for your shape profiles—within present limits of a design which can be inscribed in a three-inch circle. You'll surely boost production, cut over-all cost. For complete details write to the Jones & Laughlin Steel Corporation, Dept. **409,** 3 Gateway Center, Pittsburgh 30, Pennsylvania.

VISIT
Jones & Laughlin
Booth No. 237 at
Design Engineering Show
New York Coliseum
May 20 to 23

Jones & Laughlin STEEL ... a great name in steel

find out HOW THESE...



and many other

RUSCO ENGINEERED FABRICS

Apply to Your Design Needs

Finding new and better ways to apply TEFLON, DACRON, GLASS and numerous other synthetic and natural fibres to the current and anticipated needs of industry is a never-ending program at Russell. From high speed belts for 100,000 rpm service to high temperature oilless bearing supports . . . from nuclear reactor tapes to woven heating elements . . . from superior friction materials to amazingly flexible conveyor belts . . . from colored glass insulating tapes to TEFLON bushings and friction free linings . . . from miniature transmission belts for sound recorders to aircraft components . . . these are only a few of the diversified Rusco products which will attract hundreds of alert engineers to Booth 620 at the Design Engineering Show.

We invite you to explore the potentialities of these Rusco Engineered Fabrics in terms of your particular needs.

Put Russell — Booth 620 on your "must see" list for the Design Engineering Show, or write for information.

THE RUSSELL MANUFACTURING CO.
ENGINEERED FABRICS SINCE 1834

116 East Main Street • Middletown, Conn.

synchronizing and sweep assembly, all in the upper cabinet. The high voltage power supply, the synchronizing and sweep power supply, and Y - amplifier power supply are in the lower cabinet. Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.

For more information— Circle 102, inside back cover

Thermistor Appraisal Kits

Four engineering appraisal kits are said to help determine which thermistor is applicable to a particular circuitry problem. Each of the kits is designed to meet either a resistance range or a functional application.

Resistance ranges of the kits are: kit A is packaged with low resistance disc-type thermistors in the 10 to 500 ohm range; kit B includes disc and rod thermistors in the 1000 to 10,000 and 10,000 to 100,000 ohm range; kit C consists of ¾ in. washer-type thermistors and necessary hardware for experimental purposes.

Kit D contains 1000-ohm resistance disc thermistors to permit evaluation on the effect of thermistor mass on dynamic or static characteristics. General Electric Co., Detroit 32, Mich.

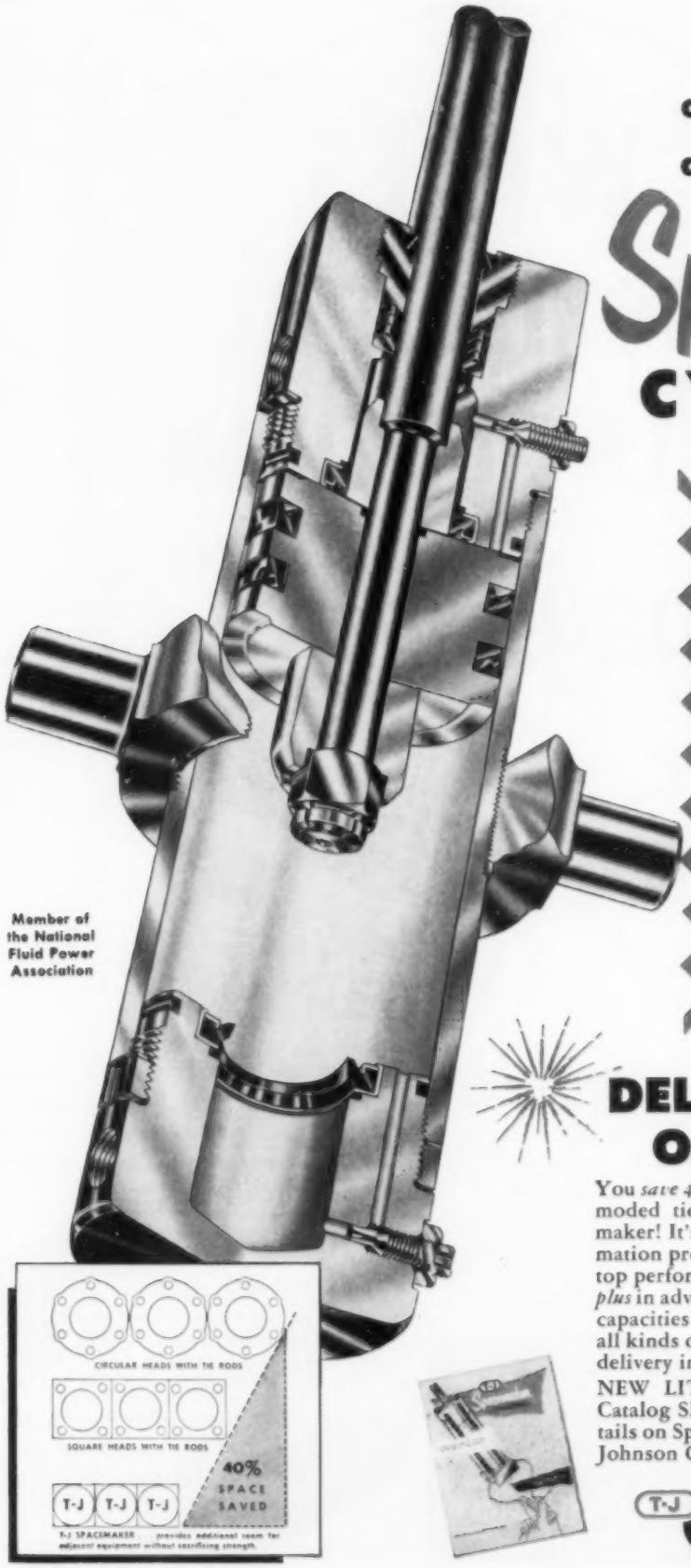
For more information— Circle 103, inside back cover

Modular Oscilloscope

The unit incorporates direct reading amplitude and time calibrations, sweep expansion, and driven and recurrent sweeps. All d-c and pre-amp-

(Continued on page 324)

all the EXTRAS are standard with T-J Spacemaker CYLINDERS



Member of the National Fluid Power Association

- **NEW** *exclusive* ingenious cushion designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Cushion for Oil.
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER**, not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.

DELIVERY OFF THE SHELF!

You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON

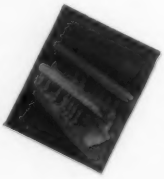
RIVETORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHERS

"WALES HORIZONTAL HOLE PUNCHING pays off!"

Punching holes in any kind of flange, angle, channel or shape is usually a costly operation requiring custom dies, but not with WALES Standard H Tooling. This exclusive self-contained tooling equipment, with interchangeable punch, die and stripping mechanism makes possible fast, economical hole punching. WALES H Tooling insures FAST set-up with automatic alignment and the same equipment may be used over and over again in any number of patterns. Bench assembly virtually eliminates press down time. H Tooling is available to meet your every production requirement.

SEND FOR BULLETIN NO. 22D

This fact filled Bulletin will give you the details. Send for your copy today.



WALES-Strippit COMPANY

A UNIT OF HOUDAILLE INDUSTRIES, INC.

AKRON, NEW YORK

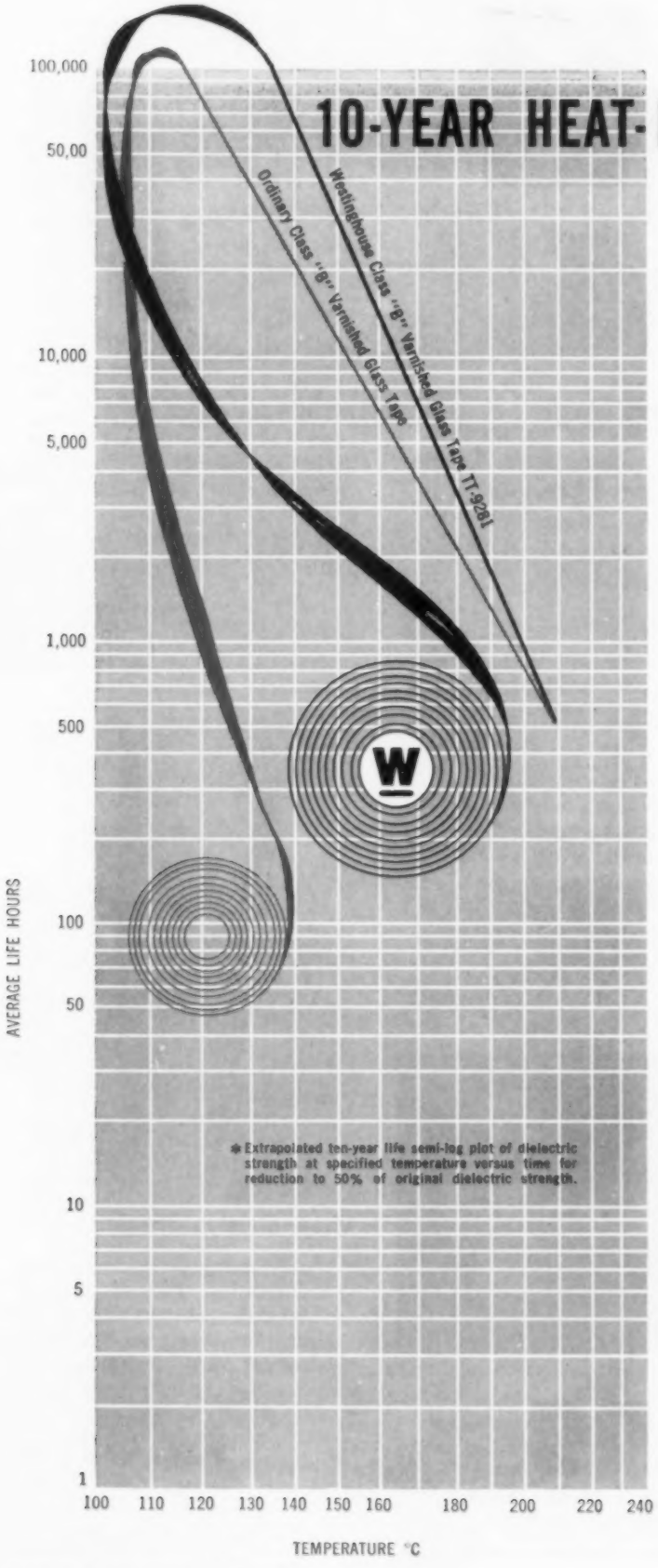
WALES-STRIPPIT OF CALIF., SOUTH GATE, CALIF.
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.

"...the Wales-Way is the PLUS-PROFIT way"

WALES MOBILE FIELD UNITS

will demonstrate WALES tooling right at your door. Ask for details. No obligation.

10-YEAR HEAT-RESISTANCE TEST



Shows Westinghouse Varnished Glass Cloth and Glass Tape Is a "True" Class "B" Insulating Material!

What do you demand of a true Class "B" insulating material?

That it provide good heat, abrasion and solvent resistance, plus high dielectric strength at 130°, of course. But for *how long?* Five *minutes?* Five *months?* Five *years?*

*Westinghouse Varnished Glass Cloth and Tape TT-9281 has shown the equivalent of ten years heat resistance at Class "B" temperatures!**

Furthermore, this amazing resistance is achieved without the sacrifice of other properties. The continuous filament glass fabric, coated with quality heat resistant resins, also provides excellent flexibility, oil resistance, tensile strength and handling characteristics.

That's why Westinghouse Varnished Glass Cloth and Tape TT-9281 is called a "true" Class "B" insulating material.

The same quality is built into the *complete* Leadership Line of Westinghouse flexible tapes, organic resins and varnishes for virtually *every* insulating specification. Whatever your insulating problem, why not call your Westinghouse sales engineer today, or send the coupon below for our complete Leadership Line catalog? J-06637

YOU CAN BE SURE...IF IT'S

Westinghouse

Westinghouse Electric Corporation
MICARTA Division, Trafford, Pa.

Please send me your *Leadership Line Catalog* on Westinghouse flexible insulation, tapes, resins and varnishes.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____

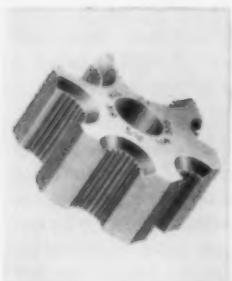
STATE_____

GIVING YOU

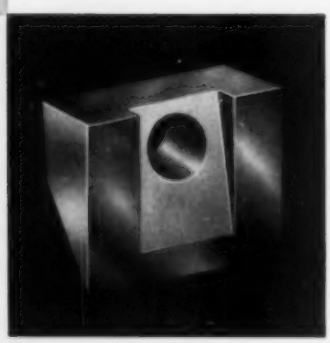
...the best and most modern!

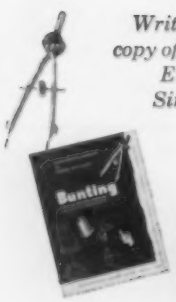
Bunting today covers a new area in the engineering and manufacture of bearings and machine parts. To the traditional line of Bunting Cast Bronze Bearings and parts is added up-to-date, soundly established facilities for engineering and manufacturing bearings and parts made of Sintered Powdered Metals.

In an entirely new plant with the very latest equipment, Bunting now attains the position in the Sintered Powdered Metals field which it has long held in the field of Cast Bronze Bearings.



A competent group of Bunting Sales Engineers in the field and a fully staffed Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.





Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

lifier heater voltages are regulated. Initially, five different modules are available: 3-in. cathode ray tube module, power supply, a sweep generator and horizontal amplifier, low frequency amplifier, and high frequency amplifier. This oscilloscope is available in portable case or rack mounting. Advanced Electronics Mfg. Corp., 2025 Pontius Ave., Los Angeles 25, Calif.

For more information—
Circle 104, inside back cover

Mechanical Lead Holders

These pencils require no sharpening or lead pointing. They are designed to take thin lead 0.031 in. thick. Weight is less than ½ oz. They have a hexagonal barrel. Automatic lead ejection and clamping feed jaws make possible one hand lead adjustment. These pencils are said to be suitable for all phases of writing, lettering and mechanical drawing. Alvin & Co., Inc., Windsor, Conn.

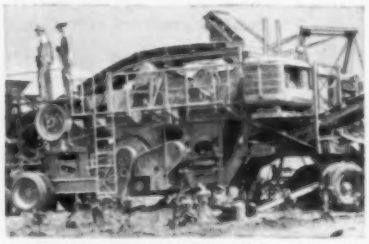
For more information—
Circle 105, inside back cover

More than 100 famous

THE GALION IRON WORKS MFG. CO. is a well-known maker of motor graders using International heavy-duty carbureted and diesel engines.

equipment manufacturers

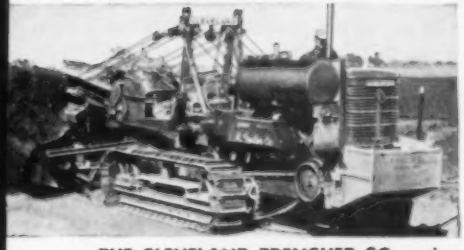
BUCYRUS-ERIE offers International engines in the broad line of shovels and construction tools the construction industry buys in volume from this famous manufacturer.



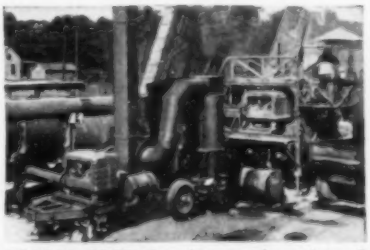
IOWA MANUFACTURING CO. makes the well-known line of Cedar Rapids crushers. Pamper-proof International diesel engines, known for high production and low maintenance, are available for their models.

WARNER & SWASEY make the do-everything Gradall® that trenches, grades, excavates, ditches, stockpiles, lifts, and loads. This famous firm solves engine problems the sure way—with International power.

power their products with



THE CLEVELAND TRENCHER CO. makes sure their models have the power for hard digging even in frozen and rocky ground without expensive maintenance downtime by making them available with International heavy-duty 4-cycle diesel engines.



BARBER-GREENE makes a wide variety of products, including this Model 845 High Type Continuous Mix Asphalt Plant. They give customers the operating dependability and economy they prefer with International power units.

SCHRAMM is known everywhere as a compressor manufacturer and products like this Model 315 are available with International diesels to keep production high and operating costs low year after year.

International® Engines

You, too, can specify International power and get the benefits of over 55 years of heavy-duty engine design and manufacturing experience. You'll get a full measure of dependable and economical power for your customers.

Our experienced installation engineers are ready to help you with your power needs. Pilot engine models are available for your research and testing programs.

These services are only surpassed by International's world-wide service facilities in the field...anywhere. That's why more than 100 equipment manufacturers power their products with Internationals. Join these shrewd power buyers by calling or writing us today.

INTERNATIONAL®

International Harvester Company
180 North Michigan Ave., Chicago 1, Ill.

CONSTRUCTION EQUIPMENT

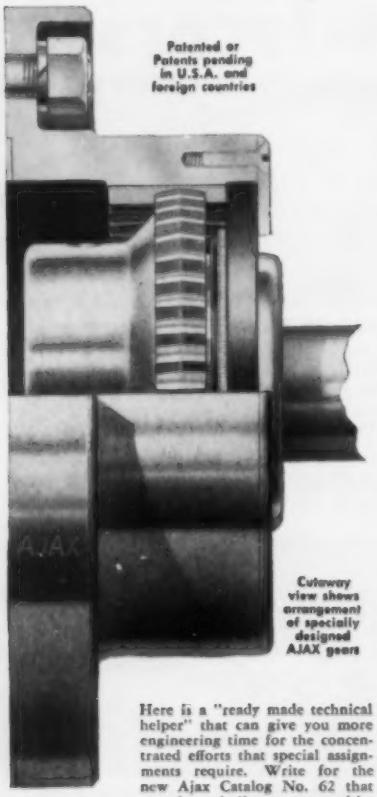
A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

AJAX

Self-aligning

DIHEDRAL COUPLINGS

Give Design Engineers An Immediate Source of Product Improvement



Cutaway view shows arrangement of specially designed AJAX gears

Here is a "ready made technical helper" that can give you more engineering time for the concentrated efforts that special assignments require. Write for the new Ajax Catalog No. 62 that contains misalignment capacities of every coupling size and type in the complete line of Ajax Dihedral Couplings. Why spend valuable time duplicating data already established by thousands of proven, field tested applications.

Ajax Dihedral Couplings handle unavoidable shaft misalignment, angular and offset, up to a total of 12°. Teeth can be cut to handle greater misalignment capacities on special order.

Get the facts on how manufacturers of presses, machine tools, rolling mills, cranes, earth moving and many other direct connected machines are simplifying design, cutting manufacturing costs and improving product performance with Ajax Dihedral Couplings.

Write today for your personal copy of Bulletin No. 62.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 348.

Metal Powder Bearings and Structural Parts–Handbook, 23 pp. Discusses sizing and bore of sintered bearings, good design vs poor design practice, secondary machining operations and special requirements, specifications of sintered metals, supplemental lubrication, tools for machining, finished machine parts, dimensional tolerances, chamfers and fillets, sintered metal gears and informative data on sealants, carburizing or carbo-nitriding. A large PV chart is shown with detailed instructions for use. Bunting Brass & Bronze Co., Toledo 1, Ohio.

Circle 106, inside back cover

Lithium–Booklet, 14 pp. Discusses following questions: What is Lithium, What Are Some Lithium Chemicals, How Are They Unique, How is Lithium Used Today, What Are Lithium Research Possibilities, What Is Lithium Availability? American Lithium Institute, 84 Nassau St., Princeton, N. J.

Circle 107, inside back cover

Brushes for FHP Equipment–Catalog B-1700 and B-1705, 33 pp. A separate section of this catalog discusses services in aircraft at high altitudes. It supplements a technical catalog on brushes for the equipment and the various brush grades available. National Carbon Co., 30 E. 42nd St., New York, N. Y.

Circle 108, inside back cover

Light and Heavy Duty Wheels–Catalog, 24 pp. Contains information and data covering a wide range of wheels, tires and drive wheels. A discussion of bearings, hubs, tires is included. Allied Wheel Products, Inc., 27 Broadway, Toledo 4, Ohio.

Circle 109, inside back cover

Drawn Cup Roller Bearings–Folder, 6 pp. Contains diagrams, data and charts on the design, installation, lubrication and load capacity of units. Torrington Co., Torrington, Conn.

Circle 110, inside back cover

Relief-Type Lubrication Fitting–Bulletin, BU-61, 4 pp. Describes unit which can be attached to bearing housings of motors, machines or pillow blocks equipped with conventional relief plugs. Keystone Lubricating Co., 3100 N. 21 St., Philadelphia 32, Pa.

Circle 111, inside back cover

Waterproof Solenoid Coil–Folder 210-3, 2 pp. Contains data on unit wound on epoxy tubing. Hays Mfg. Co., W. 12 St., Erie, Pa.

Circle 112, inside back cover

Aircraft-Type Swivel Joints–Catalog 269A, 12 pp. Contains data on plane and self-aligning units for hydraulic, pneumatic and liquid service. Barco Mfg. Co., 500-530 N. Hough St., Barrington, Ill.

Circle 113, inside back cover

Two-Way Lock Nut–Brochure, 12 pp. Contains data on a double chamfered nut with the locking power in the body of the nut, rather than at either crown. MacLean-Fogg Lock Nut Co., 5535 N. Wolcott Ave., Chicago 40, Ill.

Circle 114, inside back cover

Plug and Receptacle–Brochure, 2 pp. Contains data on disconnect, service and stud type terminal blocks. Molex Products Co., Brookfield, Ill.

Circle 115, inside back cover

Temperature Control Valve–Bulletin 505, 4 pp. Contains diagrams and data on unit for pressures up to 125 psi. Sterling, Inc., 3738 N. Holton St., Milwaukee 12, Wis.

Circle 116, inside back cover

Electric Time Controls–Catalog, 4 pp. Contains data on pushbutton, coin-operated and portable timer units. Miller-Harris Instrument Co., 601 E. Ogden Ave., Milwaukee 2, Wis.

Circle 117, inside back cover

Quick-Release Pins–Brochure, 4 pp. Contains charts and data on self-lock-

(Continued on page 329)

bright idea

For enduring beauty that sells in a new car and
re-sells in a used car . . . design it, improve it and protect it
with McLOUTH STAINLESS STEEL.

specify

McLOUTH STAINLESS STEEL

HIGH QUALITY SHEET AND STRIP

for automobiles

McLOUTH STEEL CORPORATION DETROIT, MICHIGAN

MANUFACTURERS OF STAINLESS AND CARBON STEELS

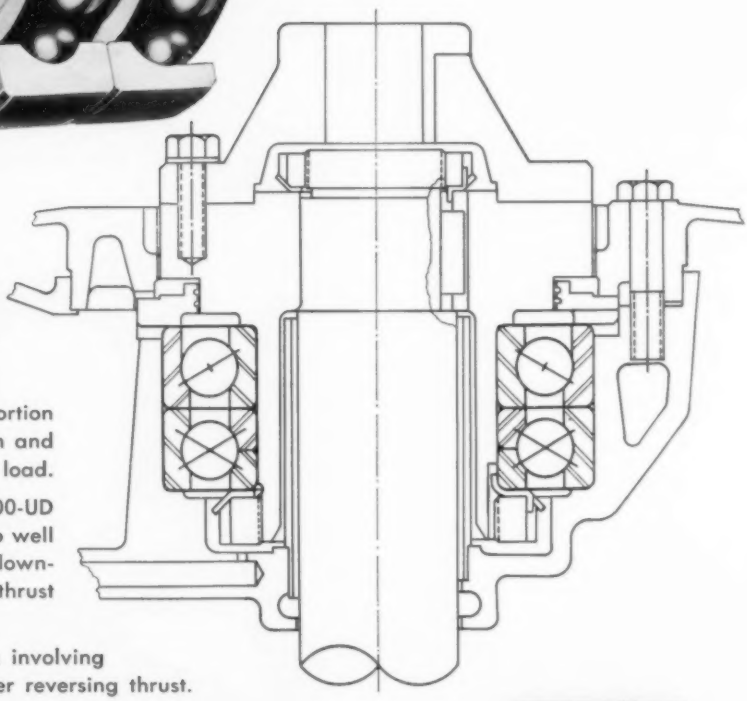
MRC 7000-D and 9000-UD

Ball Bearing Combinations

provide DOUBLE the thrust capacity available with regular Duplex bearings

M-R-C 7000-D single-row angular contact bearings and M-R-C 9000-UD single-row two-directional thrust bearings can be used in combination mountings to provide approximately double thrust capacity in one direction and single bearing thrust capacity in the opposite direction.

This combination mounting, requiring twice single-row width, results in almost 100% gain in thrust capacity in one direction, with no change in the other direction.



More than one 7000-D bearing may be used in conjunction with a 9000-UD bearing to provide still greater thrust capacity in one direction when required. The 9000-D single-row bearing performs the dual function of carrying its proportion of the heavy thrust load in one direction and supporting all of the reversing thrust load.

This combination of 7000-D and 9000-UD bearings was originally selected for deep well pump applications, supporting heavy downward thrust load as well as reversing thrust due to upsurge.

It is suitable for use in any application involving heavy thrust in one direction with lighter reversing thrust.

Consult OUR Engineering Department on YOUR bearing problems

MARLIN-ROCKWELL CORPORATION

Executive Offices: **Jamestown, N.Y.**

MRC BALL AND ROLLER *bearings*

ing units. Aviation Developments Inc., Burbank, Calif.

Circle 118, inside back cover

Simplified Practice Recommendations—Catalog 979, 14 pp. Developed by cooperation among manufacturers, catalog contains records of stock items retained after superfluous variety has been eliminated. Commodity Standards Div., U. S. Dept. of Commerce, Washington 25, D. C.

Circle 119, inside back cover

Commercial Standards—Catalog 978, 12 pp. Establishes standard quality requirements, methods of test, rating, certification and labeling of commodities, and provide uniform bases for fair competition. Commodity Standards Div., U. S. Dept. of Commerce, Washington 25, D. C.

Circle 120, inside back cover

Vinyl Sheeting—Brochure, 4 pp. Contains samples of material for lamination to metals. Masland Duraleather Co., Philadelphia 34, Pa.

Circle 121, inside back cover

Heaters and Heating Devices—Catalog GEC1005H, 72 pp. Includes information on redesigned cartridge heaters, aluminized steel sheath strip heaters, and new ratings and configurations of finned tubular heaters. Also described are ceramic-to-metal and plastic resin hermetic seals. General Electric Co., Schenectady 5, N. Y.

Circle 122, inside back cover

Timing Device—Data sheet BX219, 2 pp. Contains data on switching arrangements. M. H. Rhodes, Inc., 29 Bartholomew Ave., Hartford, Conn.

Circle 123, inside back cover

Polyphase Induction Motors—Bulletin GEC-1420, 4 pp. Contains application data on dripproof and enclosed motors, 1 to 5 hp; frames 182-215; 208-220/440, or 550 v; 60 cps. General Electric Co., Schenectady 5, N. Y.

Circle 124, inside back cover

Pushbutton Stations—Bulletin GEA-6544, 8 pp. Gives features and application information on standard and heavy-duty push buttons. General Electric Co., Schenectady 5, N. Y.

Circle 125, inside back cover

Motors For Single-Phase Application—Brochure GEA-6240A, 8 pp. Illus-

(Continued on page 332)

a NEW protective coating
for the
NEW high tensile steels
Zincilate
410
Zincilate 410 meets all requirements of Spec. MIL-P-26915 (USAF)
PREVENTS HYDROGEN EMBRITTLEMENT
REQUIRES NO COSTLY PLATING EQUIPMENT
NO LIMITATION IN SIZE OR SHAPE OF PARTS TO BE COATED

The tremendous speeds being achieved by modern aircraft have created a whole new set of design engineering problems. New steel alloys, heat treated to secure higher tensile strengths, had to be developed to withstand the heat generated by extremely high speeds, and to resist the shock of high speed landings.

These completely new high tensile steels require a completely new type of protective coating. Being subject to even greater hydrogen embrittlement than ordinary steels when cadmium plated, these new alloys require Zincilate 410, a protective coating that eliminates all traces of hydrogen embrittlement.

Zincilate 410 (one of several Zincilate formulations) provides other outstanding advantages over outmoded protection methods. Zincilate 410 will increase productive output because the controlled time cycle and size limitations of plating are eliminated. Conventional painting equipment is used to spray, dip or brush Zincilate 410, thus no more costly plating equipment. Zincilate 410 can be applied in the field, without dismantling the damaged part for return to the plating plant. And you can apply Zincilate 410 in your own plant, saving more time and money.

If your product is now being cadmium plated, all these advantages can be yours by simply using Zincilate 410. You may be surprised by the first cost, but you'll be amazed by the savings, which are far greater. Why not outline your coating problem now, on your company letterhead please, so we can tell you frankly what Zincilate 410 can do for you?

Zincilate

CORROSION-RESISTANT, ABRASION-RESISTANT, WELDABLE, AIR-DRIED and BAKED PROTECTIVE COATINGS

INDUSTRIAL METAL PROTECTIVES, INC., 404 HOMESTEAD AVE., DAYTON 8, OHIO

Rolling up the Miles

Rolling Down the Costs

Ask any user: stainless steel trailers *do* roll up extra miles. In fact, they can roll indefinitely because of their great strength and resistance to rust and wear . . . qualities in which *no other metal* matches stainless steel. Of course, that longer operational life means lower over-all expense.

But stainless helps roll down the costs (and UP the profits!) in other ways. It's so strong that thin-wall sections and structural members can be used, permitting greater payload capacity and offering additional savings in operating expenses. Painting isn't needed, and maintenance is cut to a whisper.

Such properties make stainless steel an ideal material for trailers, trains, planes, etc. They qualify it for myriad other applications, too. Chances are that *you* could use it when your product (or process equipment) requires superior strength, corrosion resistance, heat resistance, sanitary qualities, ease of fabrication, durability and attractiveness. ● We'd be pleased to discuss it with you—anytime you say or anywhere you'd like to meet. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

Write for your copy of "STAINLESS STEEL IN PRODUCT DESIGN"

40 pages of useful engineering and fabricating data, including practical examples showing where, when and how stainless steel improves design, adds benefits, helps sales.

ADDRESS DEPT. PE-89

WSW 6062 B

Make it BETTER-and LONGER LASTING-with

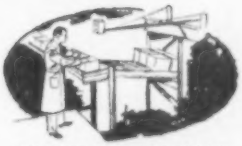
AL Stainless Steel

AL ALLEGHENY LUDLUM

Warehouse stocks carried by all Ryerson Steel plants

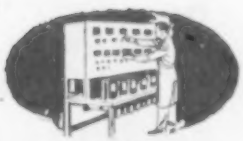
EQUIPMENT MANUFACTURERS:

PROCESS CONTROLLERS



AUTOMATIC PRODUCTION MACHINERY

VENDING MACHINES



TEST BENCHES

send for FREE sample

SMALL SIZE...LOW COST...MIDGET SOLENOID VALVE

BY THE WORLD'S LARGEST MAKER OF AUTOMATIC VALVES

NEW GENERAL CONTROLS K-27H

Multipoised—for positive operation in any position

Only 3⅛" high and 1⅞" in diameter

½" IPS electrical conduit connection or rubber grommet

All standard voltages

Waterproof coil optional

For air, gas, water, oil—all common industrial fluids.

Port sizes 7/64", 1/8" or 5/32"

Spring-loaded plunger and soft seat guarantees tight shut-off

Brass bar stock body

Weighs only 13 oz.

⅛" IPS

Normally closed, energize to open

130 psi max. operating pressure

JUST CLIP THIS COUPON TO YOUR LETTERHEAD

MAKE YOUR OWN TEST

If you make equipment that incorporates small solenoid valves, you'll want to find out first-hand about this smaller and lower cost valve that will save space, reduce costs and (most important) deliver the goods in dependable performance.

We're so convinced this new K-27H Midget Solenoid Valve will give you all three, we'd like you to try it on your equipment for size—savings and performance. Send in the attached coupon.

GENERAL CONTROLS

America's Finest Automatic Controls for Home, Industry, and the Military

Glendale, California · Skokie, Illinois

Five Plants—40 factory branch offices serving the United States and Canada

Mr. Sumner Ladd, Sales Mgr.
Industrial Controls Division
General Controls Co.
801 Allen Avenue, Glendale 1, Calif.

500-U

Please send me a **free** sample of your new K-27H Midget Solenoid Valve for test and evaluation on equipment we manufacture for sale.

NAME _____

POSITION _____

COMPANY _____

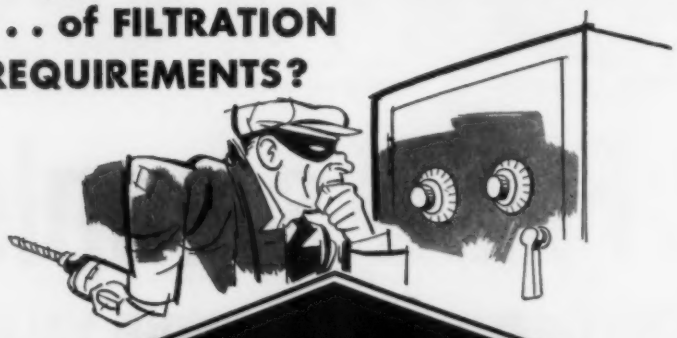
ADDRESS _____

CITY _____ **STATE** _____

TYPE OF EQUIPMENT MANUFACTURED _____

Stopped by a TOUGH Combination...

...of FILTRATION REQUIREMENTS?

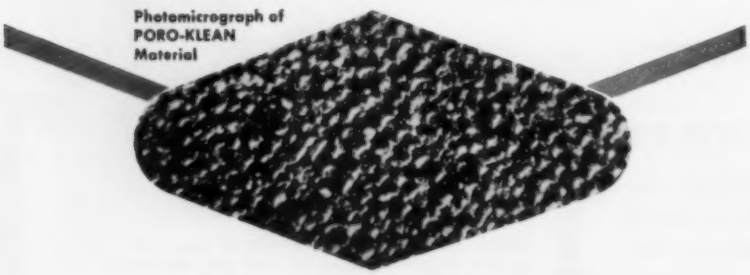


CUNO

PORO-KLEAN

THE POROUS STAINLESS STEEL MEDIUM THAT OFFERS YOU ALL THESE ADVANTAGES –

- **HIGH HEAT RESISTANCE** . . . permitting operation at temperatures as high as 900°F.
- **HIGH TENSILE STRENGTH** . . . up to 15,000 psi, allows Poro-Klean Filters to withstand differential pressures of more than 3500 psi and to handle extremely viscous liquids at relatively high flow rates.
- **HIGH CORROSION RESISTANCE** . . . allows the filtration of – or cleaning by – substances that would quickly damage other filter materials.
- **NO MEDIA DISCHARGE** . . . Cuno's unique manufacturing and control methods result in a much stronger material with *all* particles securely bonded at several points of contact. Independent tests have *proved* that Poro-Klean produces no product contamination due to media discharge . . . even under conditions of extremely high differential pressures and severe vibration.
- **UNIFORM FINE FILTRATION** . . . with standard material down to 5 microns. Material for sub-micronic filtration available on special order.



Photomicrograph of PORO-KLEAN Material

WRITE NOW FOR COMPLETE INFORMATION

CUNO ENGINEERING CORPORATION

2005 SOUTH VINE STREET, MERIDEN, CONNECTICUT

Telephone BEverly 7-5541

EDGE-TYPE, WIRE-WOUND, FIBER CARTRIDGE and POROUS METAL FILTERS

Filtration Engineers in Principal Cities

trates design advantages of single-phase capacitor type motors, 1 to 3 hp, 115/230, 60 cps. General Electric Co., Schenectady 5, N. Y.

Circle 126, inside back cover

Clad Metals–Bulletin CM901, 4 pp. Contains data and charts on clad metals, contact materials and contact assemblies. American Silver Co., 36-07 Prince St., Flushing 54, N. Y.

Circle 127, inside back cover

Heat Sheets–Brochure, 4 pp. Contains information on flexible, lightweight glass cloth-graphite film-type heating element. Electrical Coatings, Inc., Beverly, Mass.

Circle 128, inside back cover

Industrial and Decorative Laminates–Brochure, 8 pp. Contains data and charts on materials, sizes and applications for paper and fabric-base plastic. Farley and Loetscher Mfg. Co., Dubuque, Iowa.

Circle 129, inside back cover

Pumps and Pump-Motors–Catalog 957, 12 pp. Contains diagrams and data on rotary pumps and hydraulic pump-motors. Geo. D. Roper Corp., Rockford, Ill.

Circle 130, inside back cover

Speed Reducers–Bulletin 1105, 24 pp. Contains data on concentric shaft and right-angle reducers for applications up to 140 hp. Falk Corp., 3001 W. Canal St., Milwaukee 1, Wis.

Circle 131, inside back cover

Coil Springs–Brochure, 4 pp. Contains chart and data. Dudek & Bock Spring Mfg. Co., 4014-28 W. Grand Ave., Chicago 51, Ill.

Cirle 132, inside back cover

Set Screws–Catalog 21, 24 pp. Contains diagrams and charts on self-locking, headless, socket and self-tapping screws. Set Screw & Mfg. Co., Bartlett, Ill.

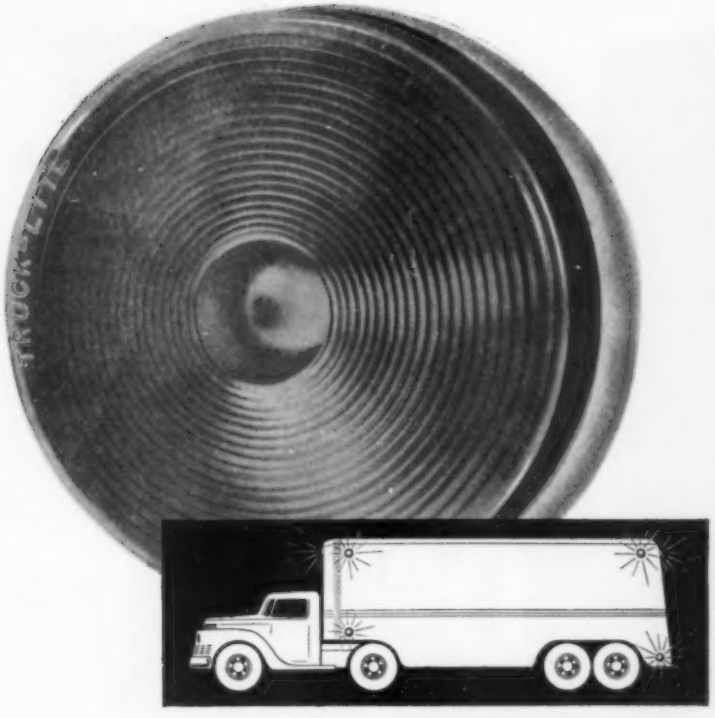
Circle 133, inside back cover

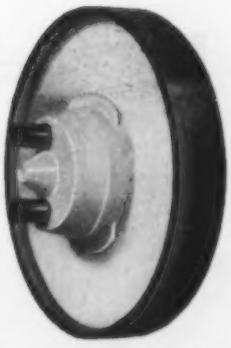
Flexible Tubing–Brochure, 16 pp. Contains data on hose, bellows and dampeners. U. S. Flexible Tubing Co,. Bartlett, Ill.

Circle 134, inside back cover

Resistance Measuring Bridges–Bulletin L-19B, 8 pp. Contains data on seven bridges covering d-c resistance

(Continued on page 336)





Rear Views showing Bulb Holders in Flush Mounted and Face Mounted Lamps

Truck-Lite created a

bright new idea in truck lighting

—Sylvania custom molded it

Truck-Lite's new all plastic, sealed, "throwaway" lamp unit is a light-saving, maintenance-saving idea in truck clearance and marker lamps.

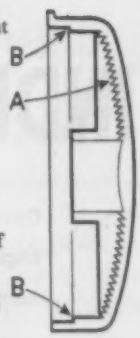
Its rustproof, shatterproof plastic lens was designed by Truck-Lite and Sylvania for brilliant wide-angle illumination. Throwaway feature combined with simple plug-in receptacle is a boon to truck-light maintenance.

Custom molding of intricate parts like the Truck-Lite lens and bulb holders is just one of the reasons leading manufacturers, large and small, come to Sylvania for consultation on parts designs.

Sylvania's Parts Division also offers complete facilities for custom metal stampings, special electronic components and special wires. For complete details of these services, write for the "Portfolio of 4-way Service to Designers."

The *Truck-Lite* lens is molded of heat-resistant methacrylate in red, green, amber and crystal. The angle of its refraction prisms (a) are molded in graduations of 1° to produce controlled illumination over a full range of 180°.

Mounting surface of the lens (b) is held to ±.002″ to insure proper seating of bulb holder and accurate positioning of the light with respect to the truck body.



See us at Booth 110 at the Design Engineering Show

SYLVANIA PARTS DIVISION

Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

SPECIAL WIRE | METAL STAMPINGS | MOLDED PLASTIC | ELECTRONIC COMPONENTS

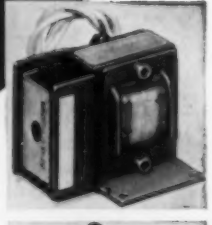
4-way service from one source

- Up to 30 pounds force. Push or pull.
- Full one inch stroke available.
- Decco shock-mounted for long life.
- High efficiency—silicon steel laminations.
- High moisture resistance.
- Shock absorbing bumpers cushion stroke.

Decco

SERIES 50

INDUSTRIAL SOLENOIDS



Your choice of mounts

Push or pull types

Direct current solenoids

Decco's Series 50 offers more power—longer stroke with the same dependable quality and performance that has made Decco the top name in industrial solenoids.

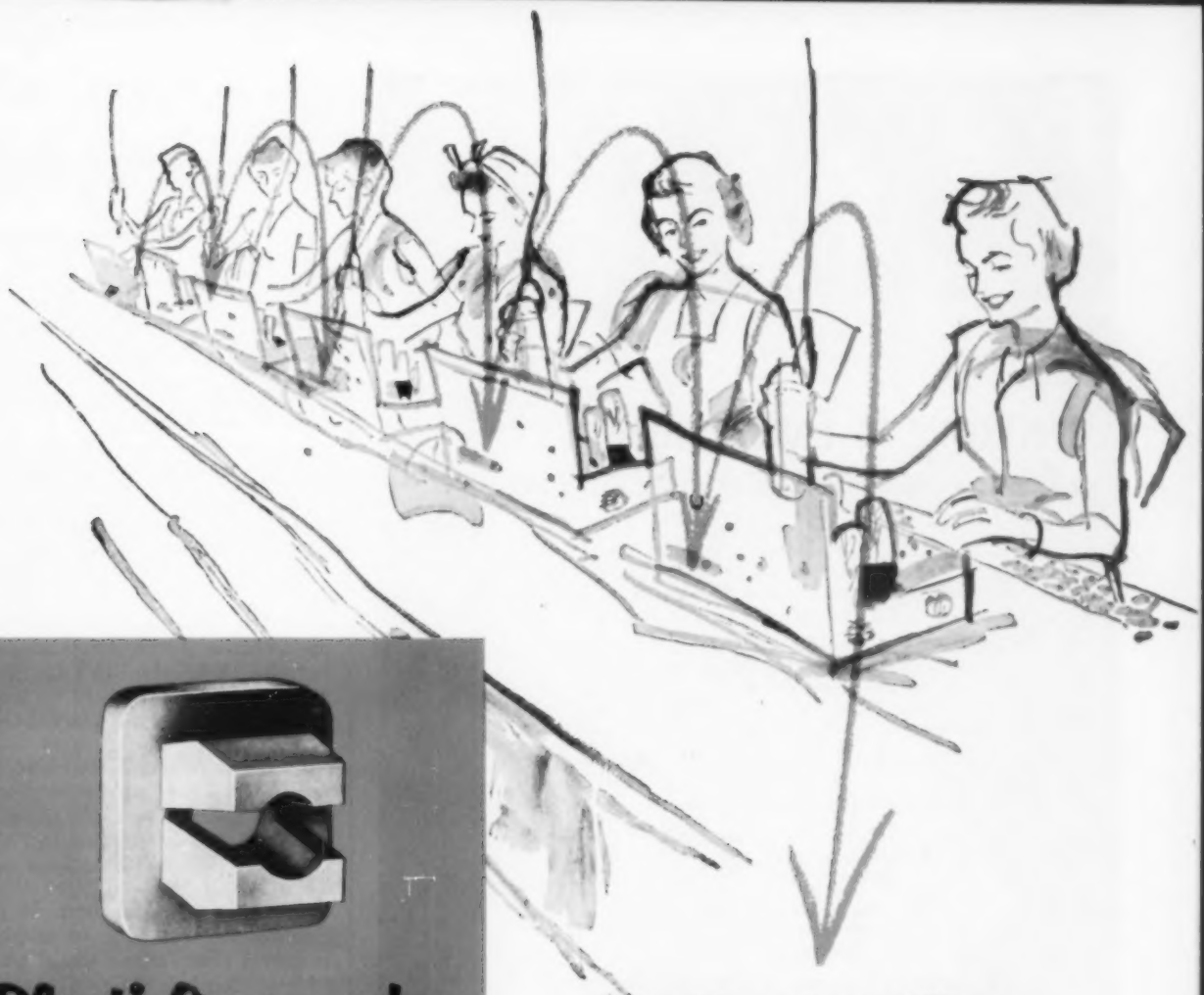
There is a Decco solenoid for every requirement. Built to give better service for a longer time. Solenoids engineered and modified to your requirements. Let us discuss your problems.

For complete information write—

Decco SOLENOIDS THE HEART OF DEPENDABLE AUTOMATION EQUIPMENT

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

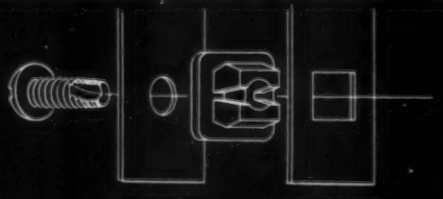


Plasti-Grommets®

Self-Retaining Blind Screw Receptacles

- non-corrosive
- non-conductive
- vibration-resistant
- does not chip or craze porcelain
- available in any color

35 sizes stocked



. . .An Easier Way to Speed Production

. . . and cut assembly costs, too! Plasti-Grommets snap into a prepared hole at the touch of a finger . . . replace other costly retained threaded receptacles, tapped holes or retained nuts. Locked in place by a thread-cutting screw, Plasti-Grommets provide a firm, durable, vibration-resistant fastener.

Developed at the Fastex creative engineering labs, Plasti-Grommets are a typical example of the simplification possible in multi-part assembly operations. Fastex volume production of metal and plastic components—on specialized manufacturing equipment—increases the economies gained through Fastex engineering ingenuity. These savings are being realized today in nearly every mass-production industry.

Test Plasti-Grommets® . . . send for informative brochure and free packet of these remarkable nylon blind screw receptacles . . . actually test them . . . see how they can reduce your costs!

FASTEX

iTW

A DIVISION OF ILLINOIS TOOL WORKS

195 Algonquin Road, Des Plaines, Illinois
In Canada: SHAKEPROOF-FASTEX,
Division of Canada Illinois Tools Ltd., Toronto, Ontario

everything in Fluorocarbons . . .
the most complete service in parts and stock
United States Gasket, pioneers and world leaders in the fabrication of duPont TEFLON, Kellogg KEL-F and other plastics, offers you unique facilities to assist in your manufacturing program.
These facilities include cold molding and sintering, extrusion, and compression molding techniques for the production of the world's most complete stock of sheets, tape, discs, rods, tubing, electrical spaghetti, bars, cylinders, and special extruded shapes.
U.S.G. also maintains a specialized machine shop for the high-speed, low-cost custom machining of parts from Fluorocarbon stock to your specifications.
In addition, U.S.G. operates an extensive compression and injection molding plant for the large-volume part requirements of its customers.
Come to U.S.G. for all your requirements—whether for stock or parts. 30 conveniently located offices and warehouses are ready to serve you.
Use U.S.G. as an unbiased yardstick for cost measurement in deciding the most efficient means of producing your parts in the quantities in which they will be required —both at the prototype stage and in ultimate production.
Write for Bulletin IN-554.
United States Gasket Company
Camden 1, New Jersey

United States Gasket Plastics Division
OF THE GARLOCK PACKING COMPANY

Catalogs and Bulletins.....continued

measurements from 1 micro-ohm to 1 million megohms to tolerances as close as ±0.02. Shallcross Mfg. Co., Collingdale, Pa.

Circle 135, inside back cover

Silicone Fluids–Brochure, 4 pp. Describes the physical and electrical characteristics of fluids now commercially available. Dow Corning Corp., Midland, Mich.

Circle 136, inside back cover

Rotary Mechanical Seals–Catalog 480, 16 pp. Contains data and cutaway views showing stuffing box installation details. Durametallic Corp., 2104 Factory St., Kalamazoo, Mich.

Circle 137, inside back cover

Shear Pin Sprockets–Folder 2749, 4 pp. Contains chart and data on units for roller chains. Link-Belt Co., Prudential Plaza, Chicago 1, Ill.

Circle 138, inside back cover

Silver Brazing Preforms–Brochure, 14 pp. Contains data on flux, rings and washers. Lucas Milhaupt Engineering Co., 5051 S. Lake Dr. Cudahy, Wis.

Circle 139, inside back cover

Gears and Pinions–Brochure, 16 pp. Contains data and tables on rawhide, laminated phenolic and special gears. Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago 22, Ill.

Circle 140, inside back cover

Silicon Iron Magnetic Tapes–Bulletin DMF4, 4 pp. Contains information on sizes, weights, tolerances and insulation of tapes in thicknesses of 0.001, 0.002, 0.003, 0.004, 0.005 and 0.007 in. Thomas & Skinner, Inc., 1178 E. 23 St., Indianapolis, Ind.

Circle 141, inside back cover

Polyamid Tubing–Bulletin BR-3A, 4 pp. Describes characteristics and installation advantages of flexible tubing. Polymer Corp. of Pa., Reading, Pa.

Circle 142, inside back cover

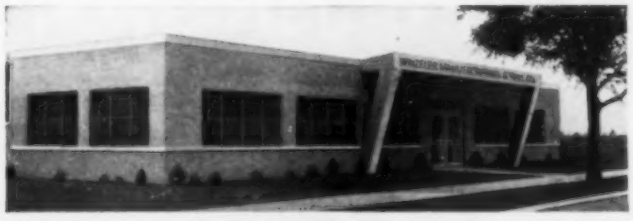
Metal Thermostats–Bulletin 3000, 2 pp. Describes bimetal disc-type unit for electronic appliance and industrial applications. Stevens Mfg. Co., Inc., Lexington, Ohio.

Circle 143, inside back cover

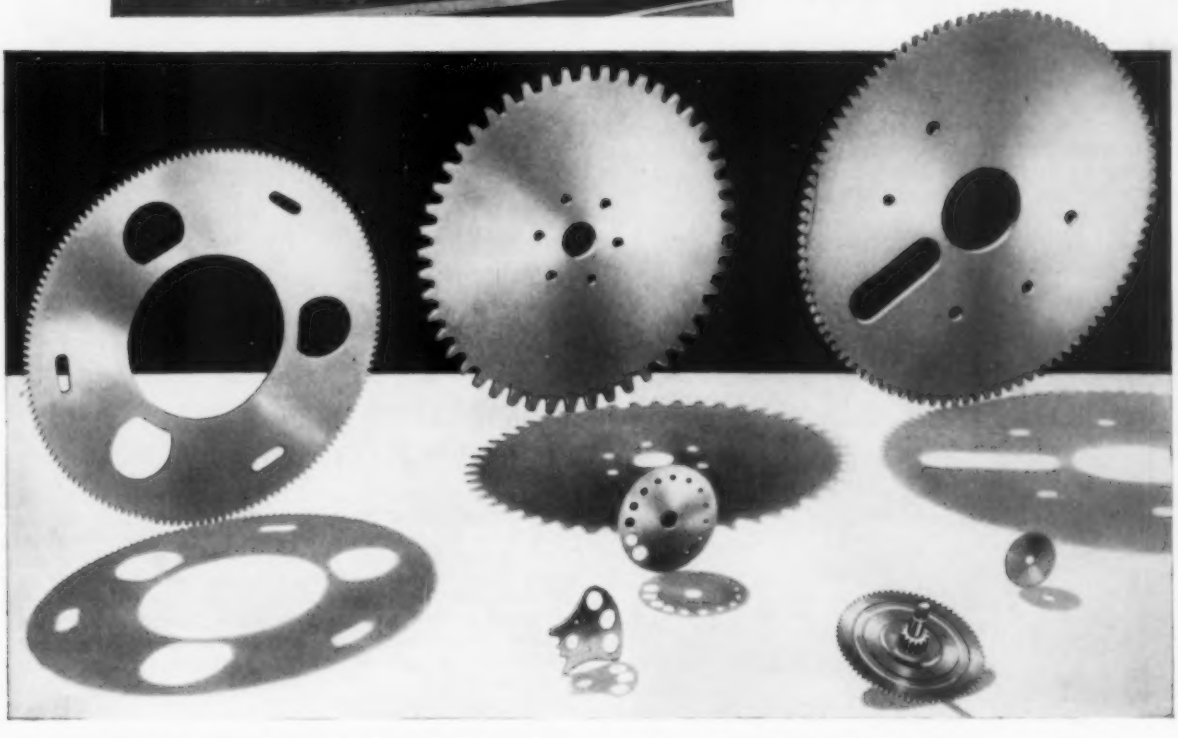
Permanet Magnets–Catalog PM-121, 12 pp. Contains information on magnetic and mechanical properties, ap-

(Continued on page 340)

The Outstanding Success of Winzeler STAMPED Gearing Results from Vastly Improved Methods of Tooling, Stamping and Inspection



Winzeler accuracy and efficiency is now greater than ever in this brand new, specially designed, one-floor plant. Here, highly developed men, methods and machines keep pace with the rapidly increasing demand for the better Stamped Gearing we make.



WINZELER is now better equipped than ever to *Stamp* Gearing in production runs. Greatly enlarged, modernized plant, methods and equipment produce Gearing by the thousands or *millions* with a degree of speed and uniform accuracy generally considered impossible! Skilled WINZELER engineers can lend you valuable aid in determining the ONE best and most economical application for your specific needs.

WINZELER now *stamps* better Gearing from *8 to 120* dp . . from .006 to 3/16" thickness and up to 7 inch diameter. Single stampings are often laminated and indexed to produce wider faces at savings up to 60%! Now, BAKELITE Gearing is successfully stamped and shaved, with special tooling, from material up to 1/8" thick. Teeth are sharp, clean-cut, uniformly accurate. Join the fast-growing group of critical customers who improve quality, performance and profits by using WINZELER *Stamped* Gearing exclusively. Write us now about *your* needs.

WINZELER
Stamped Gears

MAIL THE COUPON FOR FREE STAMPED GEAR FOLDER

WINZELER MANUFACTURING & TOOL CO.,
7355 W. WILSON AVENUE, CHICAGO 31, ILLINOIS

Gentlemen:

Please mail to me, at once, a copy of the free WINZELER Stamped Gear folder.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE ____ STATE ____

CYANAMID

PLASTICS NEWSFRONT

SOCKETS TO MATCH YOUR '57 CHRISTMAS TREE

A more colorful Christmas—1957 is in the making today. To match the trend to Christmas trees sprayed in a host of colors, Conart Co., Inc., is now molding light socket husks in a variety of colored BEETLE® Molding Compounds to be strung on matching wire strands. Sturdy, hard BEETLE is an excellent insulator, and its molded-in color resists heat and discoloration, can't chip off. Conart produces enough husks each month to stretch twice from coast to coast.

LAMINAC® SIGNS WARN OF "OPERATION ELECTROCUTION"

These LAMINAC signs point to a great experiment in sea lamprey control being conducted by U.S. Fish and Wildlife Service in the Great Lakes area. To kill these destructive eellike fish, electrically charged lines are stretched across areas where lampreys return from spawning. Passers-by are warned off by signs posted on land and in the water. To make them waterproof, with warnings that can't wash off, Perry Plastics, Inc., makes the signs of glass-reinforced LAMINAC Polyester Resin. Color is molded in, so signs never need painting and will never rot or rust away.

ANGELIQUE'S CYMEL® AEROSOL WINS CSMA AWARD

1956 saw the first successful all-plastic aerosol spray dispenser made of CYMEL Melamine Molding Compound. And it brought the top Chemical Specialties Manufacturing Association, Inc. award in the class of glass and plastic aerosols to Angelique's CYMEL dispenser for Black Satin Spray Cologne. Plastic aerosols are popular with the ladies, too—feel warm and pleasant in the hand, resist breakage and corrosion, eliminate evaporation. Their success points the way to many new packaging possibilities with CYMEL.

AMERICAN CYANAMID COMPANY
PLASTICS AND RESINS DIVISION
40A Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

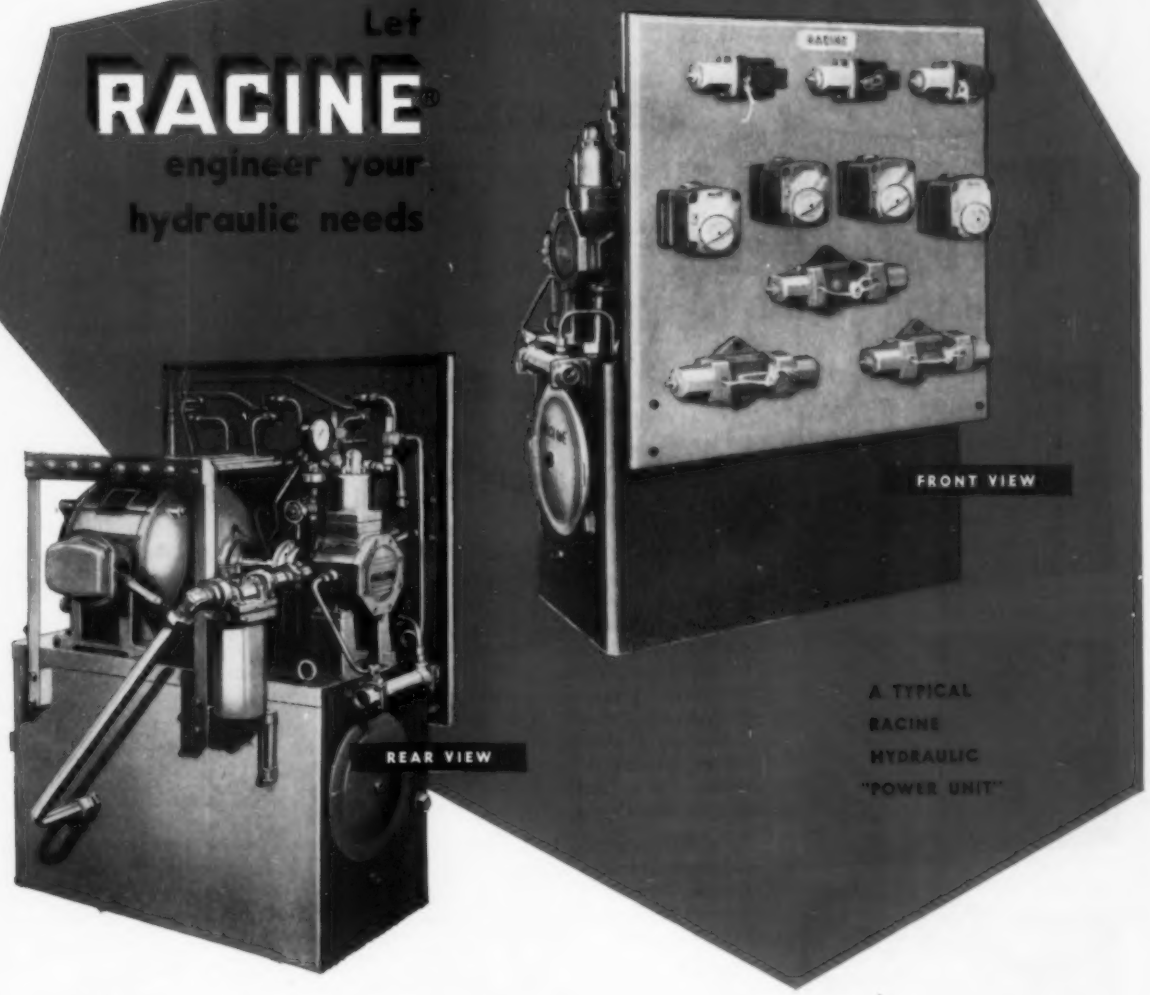
Offices *in:* Boston · Charlotte · Chicago · Cincinnati · Cleveland · Dallas · Detroit
Los Angeles · New York · Oakland · Philadelphia · St. Louis · Seattle

CYANAMID Plastics and Resins Division
MATERIALS FOR TOMORROW

Let

RACINE®

engineer your hydraulic needs



WHY RACINE FACTORY-ENGINEERED, FACTORY-ASSEMBLED *"HYDRAULIC POWER UNITS"* ARE BETTER FOR YOU!

1. Designed, engineered and built with Racine-made components to your specific machine operation needs
2. Compact — requiring a minimum of floor space
3. All components easily accessible for quick servicing
4. Complete and ready for immediate hook-up to your service lines
5. Control valves positioned on easily accessible, clearly designated control panel
6. Field sales and service representatives in all principal cities

Investigate RACINE'S *free* engineering service. Let Racine Hydraulic specialists relieve your engineering load. It will save you valuable time and money. Utilize this responsible single source of supply. Write us about your hydraulic projects. Your needs will receive prompt attention. No obligation.

RACINE — STANDARDS FOR QUALITY AND PRECISION — RACINE HYDRAULICS & MACHINERY, INC.

NFPA NATIONAL FLUID POWER ASSOCIATION Member

RACINE HYDRAULICS & MACHINERY, INC.
2072 Albert Street
RACINE, WISCONSIN

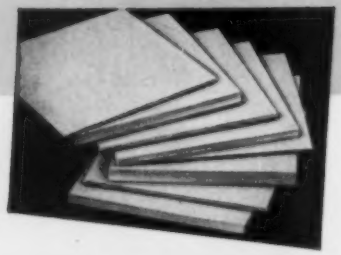
TEFLON*

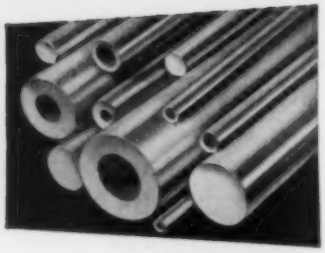
SHEET....ROD....

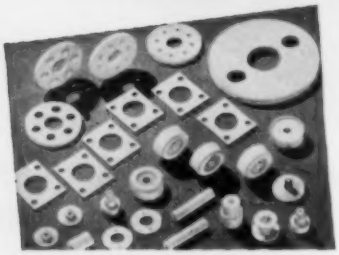
TUBING....MOLDED OR MACHINED PARTS?

YOU CAN GET JUST WHAT YOU WANT

from JOHN CRANE







"*Made of Teflon by JOHN CRANE*" has become practically a standard specification for parts and components subject to severe electrical, corrosive, thermal, mechanical or atmospheric abuse. Whatever your requirements in Teflon . . . sheet, rod, tubing, packings, gaskets, bellows, insulators, sealing discs or non-stick parts . . . "John Crane" can supply them!

In addition, you get these important *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

"John Crane's" complete fabrication facilities assure you prompt delivery on *exactly* what you want —no compromise. If you have an entirely new requirement, no standard design or procedure— "John Crane's" laboratory facilities, know how, research and engineering experience go to work on *your particular* need.

Now is a good time to put "John Crane" to test. Contact Crane Packing Company today.

*TEFLON *DuPont trademark*

Advantages:

CHEMICAL—Completely inert

ELECTRICAL—Extremely low power factor
Very high dielectric strength

THERMAL—Temperature range
—300°F. to +500°F.

MECHANICAL—Strong, flexible
Weather resistant

LOWEST COEFFICIENT OF FRICTION

ABSOLUTELY NON-STICK

Crane Packing Co.,
6445 Oakton St.,
Morton Grove, Ill.
(Chicago Suburb)

In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

SEE US AT THE DESIGN ENGINEERING SHOW BOOTH 1042

JOHN CRANE **CRANE PACKING COMPANY** 38 YEARS INDUSTRIAL PROGRESS

OFFICES IN ALL PRINCIPAL CITIES

proximate tolerances, and magnet assemblies. General Electric Co., Edmore, Mich.

Circle 144, inside back cover

Aircraft Hydraulic Pumps—Brochures (2). Covers requirements for variable delivery pumps from ¼ to 25 gpm; 0 to 3000 psi delivery, and, 1500 to 10,000 rpm. New York Air Brake Co., Watertown, N. Y.

Circle 145, inside back cover

Where to Use Aluminized Steel—Brochure PO 6456, 6 pp. Contains data on heat reflectance, heat and corrosion resistance and strength. Armco Steel Corp., Middletown, Ohio.

Circle 146, inside back cover

Solenoids, Coils and Electrical Components—Catalog, 6 pp. Contains data and diagrams. Anderson Controls, Inc., 2777 Mannheim Road, Des Plaines, Ill.

Circle 147, inside back cover

Gage Accessories—Bulletin 600, 4 pp. Describes accessories for various types of gages, dial thermometers and recorders. United States Gauge, Sellersville, Pa.

Circye 148, inside back cover

High Temperature Alloys—Booklet, 20 pp. Describes properties and fabrication characteristics of ten high-strength alloys for elevated temperature service. Carpenter Steel Co., 317 W. Bern St., Reading, Pa.

Circle 149, inside back cover

Clamps for Plastic Pipe—Catalog, 2 pp. Gives specifications and descriptive data on stainless steel clamps. Wittek Mfg. Co., 4305-37 W. 24 Pl., Chicago 23, Ill.

Circle 150, inside back cover

Plug-In Counting Circuits—Catalog 11437, 4 pp. Contains data on transistorized units. Walkirt Co., 141 W. Hazel St., Inglewood, Calif.

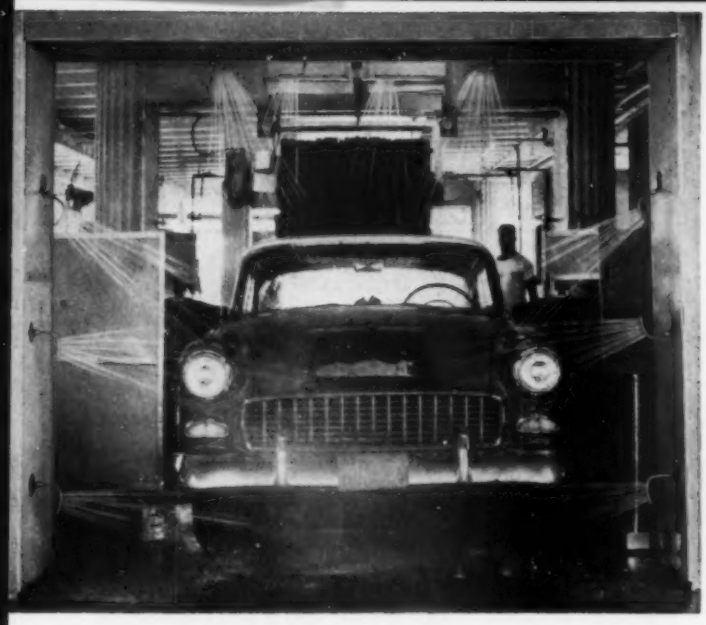
Circle 151, inside back cover

Heat Treatment and Processing of Metals—Booklet, 32 pp. Contains glossary of heat-treating terms and a series of engineering tables. Pittsburgh Commercial Heat Treating Co., 49 St. and A.V.R.R., Pittsburgh 1, Pa.

Circle 152, inside back cover

Right-Angle Bevel Gear Units—Bulletin 57, 4 pp. Contains data and lists

(Continued on page 344)

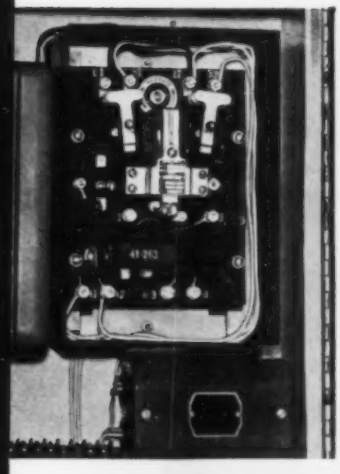


Another example of how ASCO Solenoid Valves and ASCO Relays solve unusual control problems.

How ASCO CONTROLS sequence rugged car-wash process

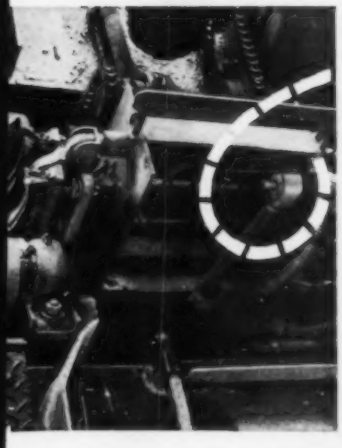
ASCO Solenoid Valves and Time Delay Relay Provide Dependable Control in Adverse Conditions

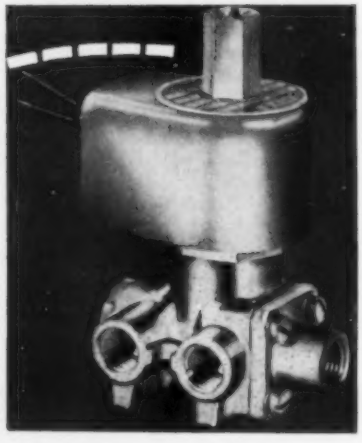
ASCO products have consistently been combined by alert engineers to provide complete automatic control systems. Here is another dramatic example. In the installation shown, Chem-Therm has linked ASCO Solenoid Valves and Time Delay Relay into a soundly engineered and economic package.



Adjusting for different car heights...

The overhead brush in this car-washing process is set for standard models. However, there is an insurance factor in the form of an ASCO Solenoid Valve and Time Delay Relay. Any outsized vehicle or obstruction will close the relay for six seconds. This causes an ASCO 3-way valve, Bulletin 8300, operating in conjunction with a single acting cylinder, to raise the overhead brush for that period of time.





Valving in slush and dirt...

The solenoid valve that controls the tire wheel brushes in this process is exposed to hot water spray and heavy dirt. That is why an ASCO durable midget 4-way valve has been specified. Special watertight molded coils insure continuous operation in the most adverse conditions. Compactness of the valve, Bulletin 8345, and the fact that it can be mounted in any position are design pluses in the close quarters of this installation.

A wide range of ASCO Solenoid Valves and Electromagnetic Control is available to provide top dependability in your sequencing and automated equipment. Write us today about your control problem.

Visit ASCO Booth 1204 at the Design Engineering Show, N. Y. Coliseum, May 20-23

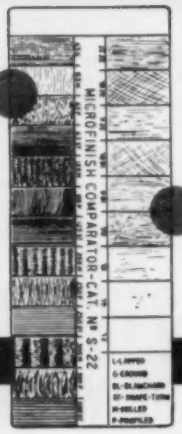
Automatic Switch Co.

54G Hanover Road, Florham Park, New Jersey

FRontier 7-4600

ASCO®

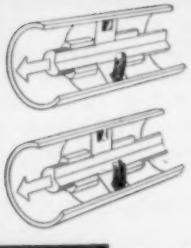
problem:



save money with a seal that needs only 60-100 micro-inch groove finish to replace O-rings that need 10-20.

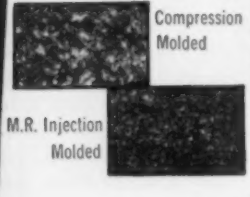
new answer:

minnesota rubber's money-saving new



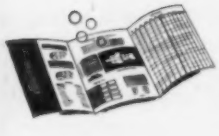
Why New Design Seals Better

QUAD RINGS eliminate "spiral twist", a common cause of packing failure. At any pressure, less squeeze is required with QUAD RINGS than with O-rings. Truly effective sealing even for pressures as low as 0-5 psi. QUAD RINGS also give a positive seal under high vacuum. The 4-lip sealing surfaces reduce breakout and running friction—giving longer life. Seal perfectly even with a rougher groove finish.



Why Minnesota Rubber Seals Last Longer

QUAD RINGS are injection molded by exclusive Minnesota Rubber process. Result is increased resistance to abrasions and chemical actions due to unequalled high density. Evidence of greater density is shown here in cross sections of Standard Buna N compound, .027" x .019", magnified 240 diameters by University of Minnesota.



Free Samples and Data

Free samples of QUAD RINGS are available together with a descriptive brochure with technical information and installation data. QUAD RINGS are the result of intensive research and field testing. Made to closest possible dimensional tolerances. We urge you to inquire about this revolutionary new seal today.

QUAD RING is a trade mark of

minnesota rubber and gasket company

Originators of modern rubber injection molding

Dept. 202 3630 Wooddale Ave., Minneapolis 16, Minn. Phone: WEst 9-6781

You can get the *custom designs* you want from a basic Skinner Solenoid Valve

In the small-size solenoid valve field, Skinner offers a wider variety of variations and optional features than any other manufacturer. Take, for example, the standard V5 model shown above in cutaway form. Its design is so flexible that the valve can be supplied for applications which would otherwise call for "specials." So, if you have a solenoid valve problem, we urge you to talk to a Skinner representative. Tell him your requirements in regard to port sizes and locations, voltages, pressures, temperature conditions, flow adjustments and mountings. Let him show you how easily he can select the valve you need.

When you specify Skinner, you get custom design plus outstanding service performance. Continuous testing in our labs and actual results in the field prove that Skinner valves have exceptional leakproof life. For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 455

Skinner Solenoid Valves are distributed nationally

See us at the Design Engineering Show, Booth 708.

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

THE CREST OF QUALITY

more than

1,001 WAYS

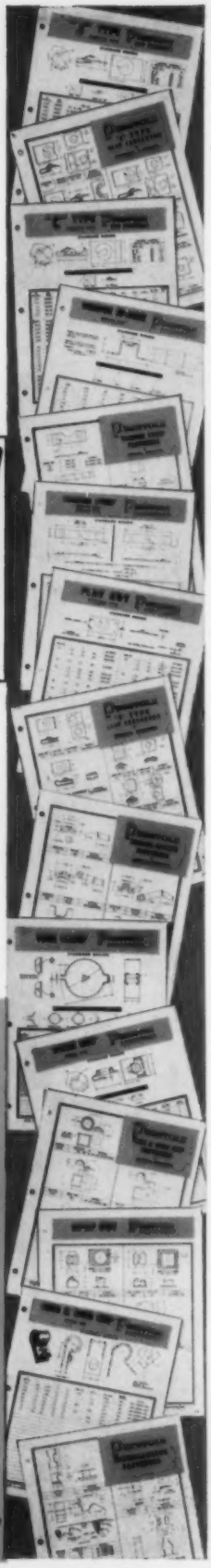
for Engineers to Solve Fastening Problems!

Your PRESTOLE representative has this volume of fastener information now—and will be glad to review it with you at your convenience.
See list below

PRESTOLE—designers and producers of precision-built, cost-saving, industrial fasteners of all types—has just completed a new volume of standard fastener data, designed to assist industrial design engineers in finding the *right* fastener for every application.

Complete, illustrated, specification-type data, based on years of fastening "know-how", is listed on every type of Prestole fastener available.

There is a method to solve any fastening problem . . . and Prestole has it! Let our representative call and show you how. No obligation, of course!



CALIFORNIA—LOS ANGELES
39 • Fred F. Alleman
Box 39685 • Griffith Station

CONNECTICUT—
MANCHESTER
Joseph Murphy • 808 Main St.

ILLINOIS—CHICAGO 39
Everett Bernardo
5625 W. Fullerton Ave.

MICHIGAN—DETROIT
Frank J. Brady Co.
2405 W. McNichols

MISSOURI—ST. LOUIS 10
Edwards Sales Agency
3687 Market St.

NEW JERSEY—FAIR LAWN
Electronic Sales Associates, Inc.
13-08 Merlot Ave.

NEW YORK—DE WITT 14
A. J. Murphy Co.
P. O. Box 216

OHIO—CINCINNATI 27
John G. Simon
Marlemont Center Bldg.
6814 Miami Rd.

CLEVELAND 22—
Wm. C. First • P. O. Box 588

TOLEDO 5—
Ervin Zahn • Prestole Corp.
1345 Miami St.

PENNSYLVANIA—
PHILADELPHIA 44
William J. Noonan, Jr.
38 Maplewood Ave.

TENNESSEE—CHATTANOOGA
Poirson-Deakins Co.
823 Chattanooga Bank Bldg.

TEXAS—DALLAS 29
W. P. Schoenfeld
4407 Northcrest Rd.

WASHINGTON—SEATTLE 8
Charles Industrial Sales Co.
5201 First Avenue, South

CANADA—OAKVILLE, ONT.
E. G. Bradner • P. O. Box 213

PRESTOLE Corporation
1345 MIAMI STREET, TOLEDO 5, OHIO

rated horsepower and speed for 12 standard models. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside, N. J.

Circle 153, inside back cover

Teflon Tubing—Brochure, 2 pp. Contains data on the dielectric strength, handling and performance of spaghetti tubing. Polymer Corp. of Pa., Reading, Pa.

Circle 154, inside back cover

Door Operator Motors—Bulletin GEA-6299, 4 pp. Gives application and design features on units ½ through ¾ hp for commercial, industrial and domestic applications. General Electric Co., Schenectady 5, N. Y.

Circle 155, inside back cover

Conversion Factors—Wall chart. Included are common conversions such as inches to centimeters, watts to hp, cu ft to liters. Precision Equipment Co., 3714 N. Milwaukee Ave., Chicago 41, Ill.

Circle 156, inside back cover

Conveyor and Elevator Belts—Catalog 25CB, 21 pp. Gives tension ratings for vulcanized and metal splices, minimum recommended pulley diameters and minimum belt width for good troughing. Also data on hot material belts for temperatures from 150 to 350 F. Raybestos-Manhattan, Inc. Manhattan Rubber Div., Passaic, N. J.

Circle 157, inside back cover

Self-Tapping and Locking Studs—Brochure, 4 pp. Contains charts and data. Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago 50, Ill.

Circle 158, inside back cover

Reusable Hose Couplings—Form 40-1, 12 pp. Contains data and charts on couplings, components and adapters. Alemite Div., Stewart-Warner Corp., Chicago 14, Ill.

Circle 159, inside back cover

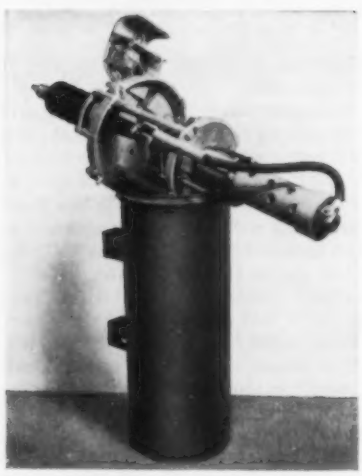
Driers, Filters and Valves—Brochure, 8 pp. Contains diagrams and data on check valves, drier-filters, flare nuts and liquid indicators for refrigeration equipment. Remco Inc., Zelienople, Pa.

Circle 160, inside back cover

Fasteners—Booklet, 14 pp. Describes pin and stump-type units covering $\frac{5}{16}$, $\frac{1}{4}$, $\frac{7}{16}$ and $\frac{3}{8}$ in. nominal diameters for

(Continued on page 348)

and you put Synthane laminated plastics to work



Automatic Circuit Recloser Parts made from Synthane sheet and tube provide insulation for high voltages.

Think of the many conveniences available simply by plugging into an electrical outlet.

On both sides of the outlet Synthane laminated plastics are at work in power generation and distribution, home appliances and other electrical equipment.

You find Synthane laminated plastics in circuit breakers, buss bar coverings, transformers. Synthane laminated plastics are important insulators in toasters, ranges, food mixers. Synthane is at work in thermostats, voltage regulators, power tools.

Synthane is valued in electrical applications chiefly for its high dielectric strength, low moisture absorption and low dissipation factor plus its additional properties of dimensional stability, machinability and mechanical strength. Synthane is available in over 30 standard grades in sheet, rods, tubes or you can avail yourself of our complete fabricating services.

For more information about the many properties of Synthane and how you can benefit by using Synthane materials and fabricating services, write for our product catalog. Synthane Corporation, 4 River Road, Oaks, Pennsylvania.

DIELECTRIC STRENGTH IMPACT STRENGTH HEAT RESISTANCE LIGHT WEIGHT

SYNTHANE ... industry's unseen essential

SYNTHANE CORPORATION, 4 RIVER ROAD, OAKS, PA.

Visit the KENNAMETAL* Exhibit...

Design Engineering Show, Booth 923, 2nd floor
New York Coliseum, May 20-23

See the KENTANIUM* Demonstrations

...how this titanium carbide PERFORMS at 2000° F

One of several demonstrations we will have at the Design Engineering Show in New York City will show the exceptional resistance of Kentanium to oxidation at elevated temperatures. (Note the accompanying report of a recent test.) This suggests how well Kentanium will perform at 2000°F. Come in and see this dramatic demonstration. It quickly demonstrates one of the many unique properties of Kentanium and may suggest applications where it can help you.

...see these other demonstrations

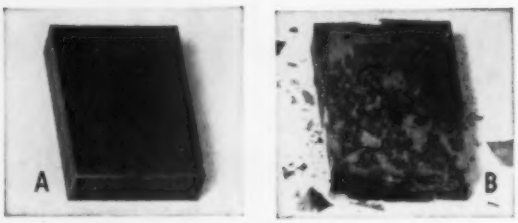
1 **THERMAL SHOCK:** Another demonstration will show the effect on Kentanium when first heated to 2000°F and then cooled to 300°F in approximately one minute. Be sure to see it.

2 **HIGH MODULUS:** This demonstration shows the high rigidity of Kentanium—approximately twice that of the hardest steel alloy. Kentanium has the highest stiffness to weight ratio of any material.

3 **WEAR-RESISTANT** properties of Kentanium while heated to a high temperature and subjected to severe wear conditions.

...and see these high purity (99.5%) metals and compounds

Columbium (Niobium)—powders, granules and bars
Columbium (Niobium) Oxide
Tantalum • Tantalum Oxide • Various Carbides



KENTANIUM unharmed at 2000° F while heat-resistant nickel-chrome alloy disintegrates

Here's proof of Kentanium's exceptional resistance to oxidation at high temperatures.

A square of K161B Kentanium and a similar square of well-known, heat-resistant 35 chromium-15 nickel alloy were exposed for 120 hours in an unsealed muffle furnace heated to 2000°F. The accompanying photographs vividly show how each piece was affected. While Kentanium (See "A") is still good for hours of exposure at high temperatures, the nickel-chrome alloy (See "B") has oxidized badly and has begun to disintegrate.

Combined with its high resistance to oxidation, Kentanium has great strength and resistance to corrosion.

These characteristics suggest how well Kentanium will perform in such applications as furnace parts, heat-treating fixtures, quench guide rings, turbine blades, nozzle vanes, bushings and other parts where strength at high temperatures, plus high resistance to oxidation, are factors.

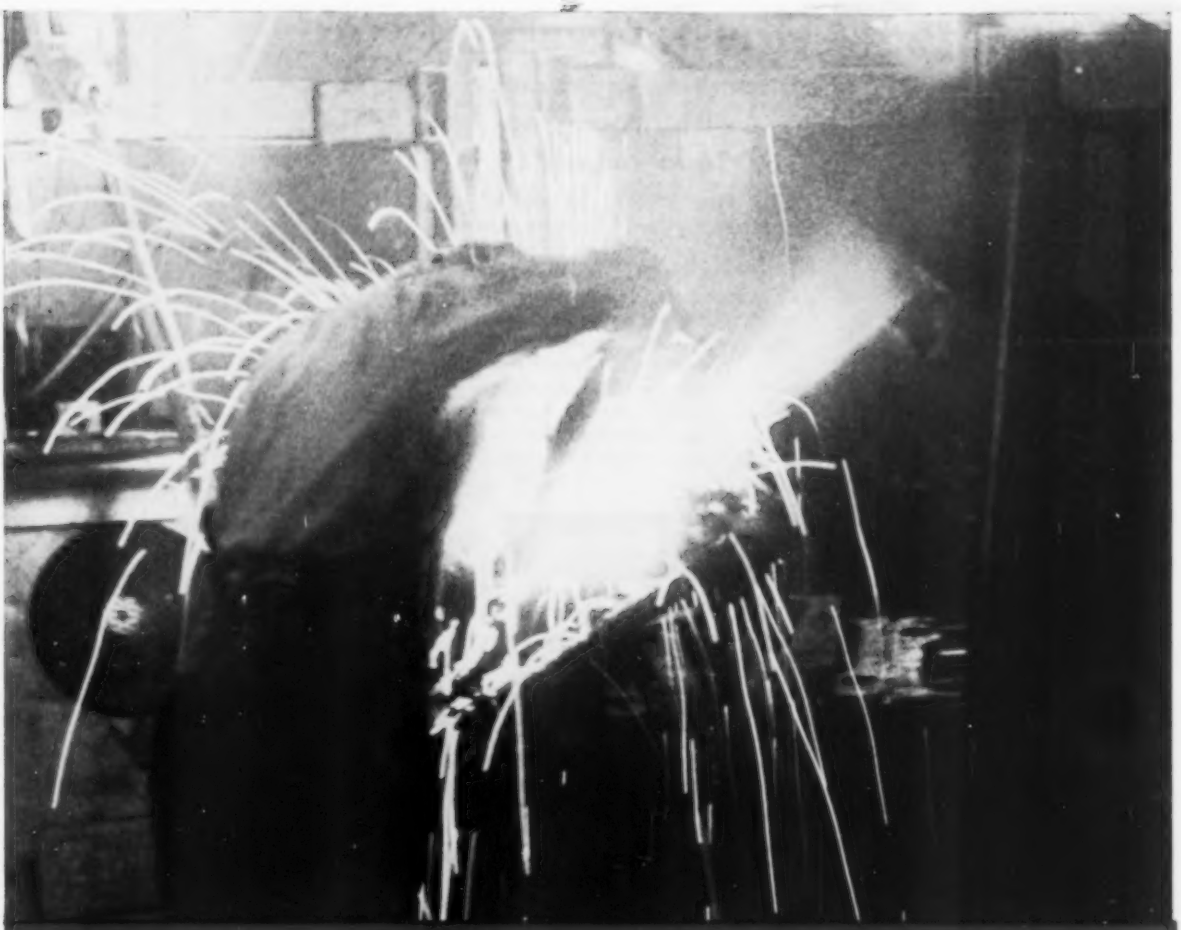
C-3016B

If you do not plan to attend the Design Engineering Show, send for copies of our "Characteristics" booklet No. 111-A and "Design" booklet No. 222. Write KENNAMETAL INC., Latrobe, Pennsylvania.

*Trademarks

See our catalog in Section 1b/Ke, Product Design File, Sweet's Catalog

INDUSTRY AND KENNAMETAL ...Partners in Progress



Houghto-Safe Needed Here

Let a leaking lift truck leave a pool of oil here. Let a pressure line break. Let a reservoir run over. Let just a welding spark go astray where hydraulic oil is free and . . .

Whoosh! You've got trouble on your hands.

We see it in the papers almost every day. People are still finding out about hydraulic fire hazards the hard way. Industry today is more safety conscious than ever before, yet you'll still find people who shake their heads with amazement when they hear the facts about hydraulic fire danger.

Under no more than normal working pressures, hydraulic fluid has sprayed as much as 75 feet—to touch off disastrous fires. Any piece of hydraulic machinery that ever comes this close to high temperature hazards—no matter how briefly or how seldom—can be a potential flamethrower.

But hydraulic fires need never happen. No matter what the hydraulic application, there's a Houghton Houghto-Safe fluid that will provide top-grade efficiency with complete fire safety. Ask your Houghton man.

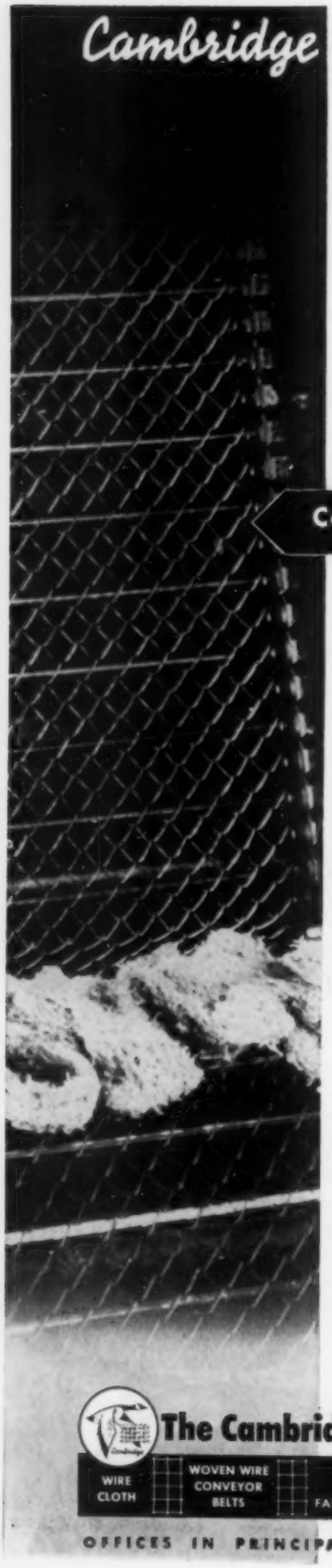
HOUGHTO-SAFE

. . . a product of

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .



Cambridge

WOVEN WIRE BELTS

combine movement with processing to lower costs

Regardless of what you process . . . metal parts, food products, chemicals, plastics, ceramics or glass . . . a continuous belt-to-belt flow on woven wire conveyor belts combines movement with processing to eliminate batch handling and cut operating costs. Controlled speeds through any type of manufacturing process . . . hot or cold, wet or dry . . . increase product uniformity and help maintain capacity production. EXAMPLE:

Continuous Drying

MOVING BELTS carry fibres through drying oven in steady, continuous operation.

OPEN MESH allows free circulation of heat or process atmospheres around all parts of product. In washing or chemical treating operations, open mesh permits quick drainage of process solutions, uniform treatment of material.

ALL METAL BELT easily withstands temperatures from sub-zero up to 2100°F.; rust-proof alloys can be used for operation in corrosive conditions.

WOVEN WIRE CONSTRUCTION provides extra strength, extra long life. There are no seams, lacers or fasteners to break or wear.

SPECIAL RAISED EDGES or surface attachments are available to hold even smallest parts in position on the belt during flat or inclined movement.

Regardless of your industry . . . metal working, food, chemical, glass or ceramics . . . you'll find combined movement and processing practical and economical in machines for your own operation or for resale. Cambridge Woven Wire Conveyor Belts are made in any size, mesh or weave, from any metal or alloy to do the job you want . . . hot or cold, wet or dry. Call your Cambridge Field Engineer to discuss how you can cut operating costs with woven wire conveyor belts. Look under "Belting, Mechanical" in the *Yellow Pages*. Or, write for FREE 130-PAGE REFERENCE MANUAL.

The Cambridge Wire Cloth Co.

WIRE CLOTH | WOVEN WIRE CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

Department P, Cambridge 5, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Catalogs and Bulletins . . . . . continued

each. Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich.

Circle 161, inside back cover

Switches—Brochure, 4 pp. Contains data on rotary selectors, pushbuttons, toggles and door interlocks. Micro Switch, Freeport, Ill.

Circle 162, inside back cover

Sheaves—Bulletin 20B8524, 4 pp. Contains data on units designed for low horsepower applications. Allis-Chalmers Mfg. Co., S. 70 St., Milwaukee, Wisc.

Circle 163, inside back cover

Grommet V-Belts—Bulletin 20B6497C, 4 pp. Contains data on units. Allis-Chalmers Mfg. Co., S. 70 St., Milwaukee 1, Wisc.

Circle 164, inside back cover

Gaskets and Shims—Booklet, 4 pp. Contains data on material produced in 12 gages from 0.001 to 0.30 in. General Gasket, Inc., Industrial Rd., Clifton, N. J.

Circle 165, inside back cover

Lubricant for Bearings—Brochure, 8 pp. Contains data on a self-wicking combination of oil and cellulose-base fibers. Fluidwick Co., 5319 E. Outer Dr., Detroit 34, Mich.

Circle 166, inside back cover

Thread-Cutting Screws—Catalog, 31 pp. Contains diagrams, specifications, and charts of assorted screws. Shakeproof, St. Charles Rd., Elgin, Ill.

Circle 167, inside back cover

Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

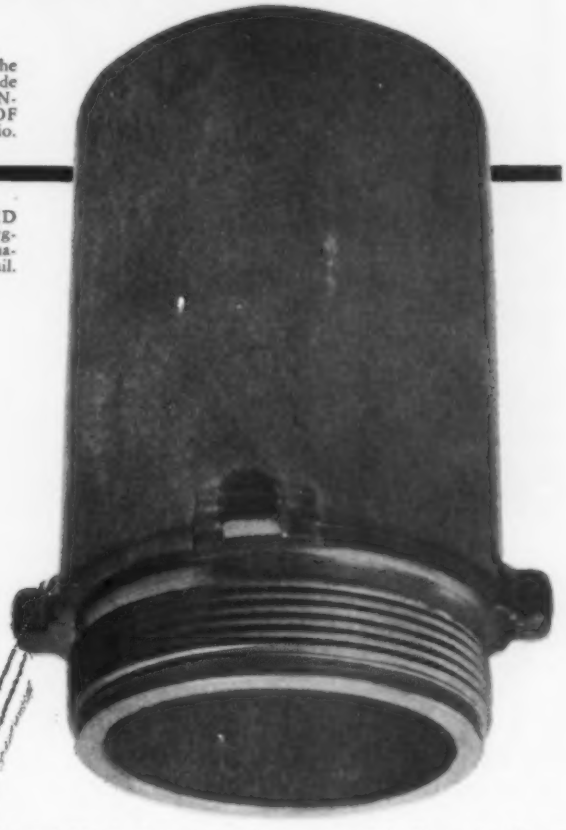
Interference-Fit Thread—As administrative sponsor for sectional committee B1 on standardization and unification of screw threads, the ASME announces the distribution of this proposal for comment. ASME, 29 W. 39 St., New York 18, N. Y.

Special-Purpose Steels—Catalog, 232 pp. Index lists 16 categories of steels, including high-speed, tool, stainless, alloy and machinery, available in 16,000 grades and sizes. Describes over 700 products available from stock at Crucible Steel Co. of America, Box 1558, Pittsburgh 30, Pa.

"Automatic" Sprinkler CUTS COSTS 20%

(Left) CUT-AWAY view of the recessed Sprinkler head made by "AUTOMATIC" SPRINKLER CORPORATION OF AMERICA, Youngstown, Ohio.

(Right) UNRETOUCHED PHOTO of Revere Brass Forging sprinkler body before machining, enlarged to show detail.



. . . by switching to

REVERE BRASS FORGINGS

HOW SAVINGS WERE MADE

PRESSURE TESTING AND REJECTS ELIMINATED . . . ASSEMBLY RATE NEARLY DOUBLED . . . PRODUCT APPEARANCE IMPROVED

COPPER • BRASS • 18 01 • REVERE • ALUMINUM

The sprinkler body you see above was originally made of cast bronze. In order to obtain the close tolerances required, the casting had to be excessively machined. In addition, each casting, after machining and prior to assembly, had to be pressure tested. Due to porosity many castings failed and rejects piled up.

Engineers of the "Automatic" Sprinkler Corporation of America consulted with Revere's Technical Advisory Service and as a result asked Revere to make up a forging. After extensive tests, the Revere Brass Forging was adopted, because it was found that closer tolerances with a minimum of machining were possible, elimination of sand holes did away with rejects entirely, pressure testing was no longer necessary and better appearance made a more sales-appealing product.

Here you have still another money-saving example of Revere supplying the right metal in the right form to do the best possible job with the greatest economy . . . whether it is brass, copper or aluminum or any one of their alloys. Perhaps Revere can help you.

THIS STORE is a typical example of how the "Automatic 400" Ceiling Sprinkler fits into modern decor, extending approximately only about ½" below the ceiling line.

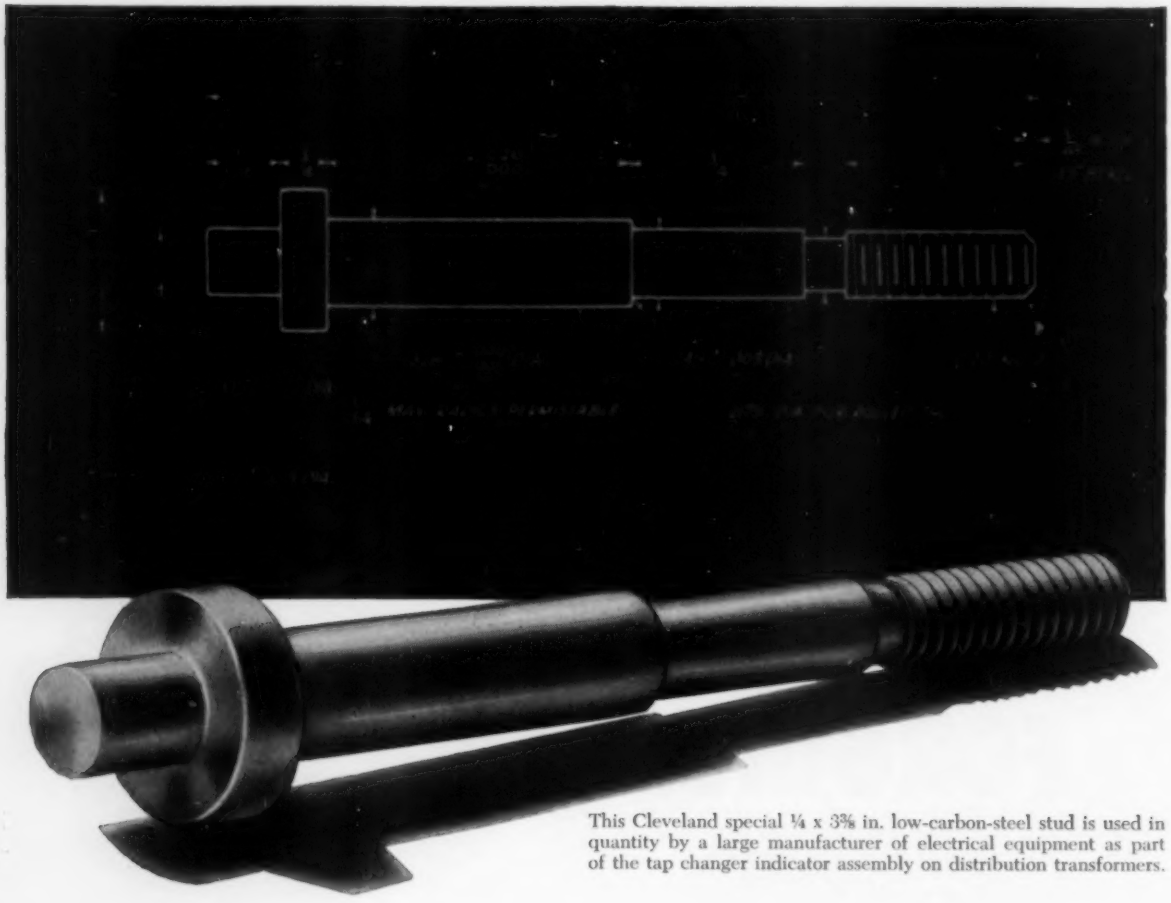
REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Rome Manufacturing Company Division, Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere

SEND TODAY FOR THIS INFORMATIVE CATALOG: Address: Revere Copper and Brass Incorporated, Rome Manufacturing Company Division, P. O. Box 111, Rome, N.Y.

CLEVELAND SPECIAL HEADED AND THREADED PRODUCTS



This Cleveland special ¼ x 3⅜ in. low-carbon-steel stud is used in quantity by a large manufacturer of electrical equipment as part of the tap changer indicator assembly on distribution transformers.

Cost of special collar stud is cut 20% by Cleveland's cold forming techniques

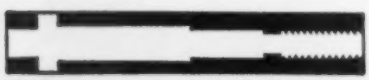
The famous Kaufman Double Extrusion Process which turns out millions of Cleveland precision cap screws yearly is highly adaptable to low-cost production of your fastener-type specials.

The tap changer stud pictured above is typical. Used by a well-known electrical equipment manufacturer, it was previously cut from bar stock. The special head, double shoulders, and groove above the threads meant numerous machining operations and considerable scrap.

Cleveland now cold forms this special stud at 20% less cost to the customer, while holding the specified .005 in. tolerance. And the part is stronger. In the head, threads and fillets, grain flow is symmetrical and unbroken. In addition, the forging action of the Kaufman process toughens surface metal while leaving the core ductile. Both fatigue resistance and tensile strength are thus increased.

We are regularly cold forming close-tolerance specials—many with unusual or extreme upsets—in large quantities. So whether your part is simple or complex, it will pay you to check with Cleveland, particularly at the design stage. There is an excellent chance that through cold forming we can cut the cost and improve the physical properties of the part you have in mind.

♦ ♦ ♦



Black area represents metal that had to be cut away when stud was produced by machining. In the Cleveland cold forming process almost all the metal in the working slug is present in the finished part. The customer saves the difference.

Write for a copy of our folder "Specials by Specialists"

THE CLEVELAND CAP SCREW COMPANY
4444-4 Lee Road, Cleveland 28, Ohio

Again and Again and Again

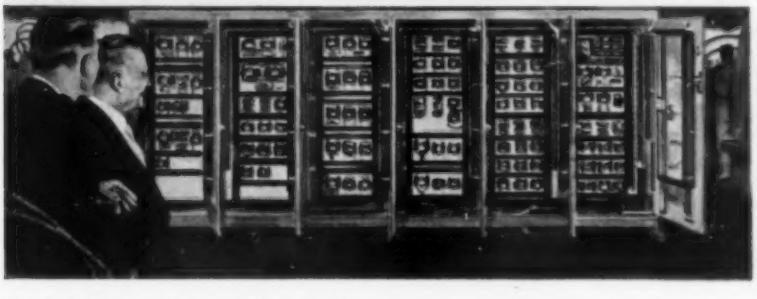
THE CHOICE OF THE LEADERS
THE MARK OF BETTER MACHINES

W. F. & John Barnes, a leading builder of machine tools and automation installations, standardizes on the use of Cutler-Hammer motor control equipment

Barnes Multiple Station "Progress-Thru" Machine which performs a total of 54 operations on automotive cylinder heads in a continuous automatic cycle. Cutler-Hammer Three-Star Motor Control and Heavy Duty Oil-Tight Pushbuttons are standard original equipment.

N. P. Bashor, Manager, Electrical Division, W. F. & John Barnes Company, recognized as an authority on machine tool control, says, "We are forever seeking improved techniques and equipment for Barnes machines. The extent to which we have standardized on Cutler-Hammer Three-Star Motor Control and Cutler-Hammer Heavy Duty Oil-Tight Pushbuttons simply reflects our conviction that these are the very best available."

Control cabinet doors of Barnes machine opened to show array of Cutler-Hammer Three-Star Motor Control components used.



The W. F. & John Barnes Company, Rockford, Illinois, has designed and built highly specialized mechanical, electrical and hydraulic equipment and machines for more than 80 years. Their unusually competent Electrical Division has repeatedly won distinction in the custom designing and building of complex electrical control systems, particularly in advanced automation engineering. Their choice of Cutler-Hammer Three-Star Motor Control and Cutler-Hammer Heavy Duty Oil-Tight Pushbuttons, in their own words, "simply reflects our conviction that these are the very best available."

Cutler-Hammer Three-Star Motor Control and Cutler-Hammer Heavy Duty Oil-Tight Pushbuttons are the decided preference of able engineers whenever selection is determined by careful comparison. To be sure, you too should standardize on Cutler-Hammer . . . the choice of the leaders, the mark of better machines.

CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

CUTLER-HAMMER
★ ★ ★
MOTOR CONTROL
C-H

Control systems for Barnes machines include the unique Barnes Electro-Graphic Detector which can cut trouble-shooting time as much as 90%. Detector circuits permit simple, speedy and safe pinpointing of any operating difficulties. With this detector, plant electricians do not have to be machine designers to be experts in supervisory maintenance.

NOW, hopper-fed headless set screws **AUTOMATE SUB ASSEMBLY!**

CUT Operational Time 80% to 90%
CUT Floor Area
CUT Floor Waste from 30% to 0
CUT Worker Fatigue

The new Setko System can be used for almost any headless set screw application in sub or final assembly. All type points and most popular styles of set screws can be hopper fed.

The illustration above shows the Syntron vibratory hopper and exclusive Setko orienting device which is the heart of this new system. This orienting device assures correct positioning of set screws as small as #2 (.086" x 1/8"). Other Setko innovations include photo-electric cell control of feed flow, air power, and micro-switch actuation of the driver.

HEXAGON AND FLUTED SOCKET SET SCREWS | SLOTTED SET SCREWS | SLABBED SET SCREWS

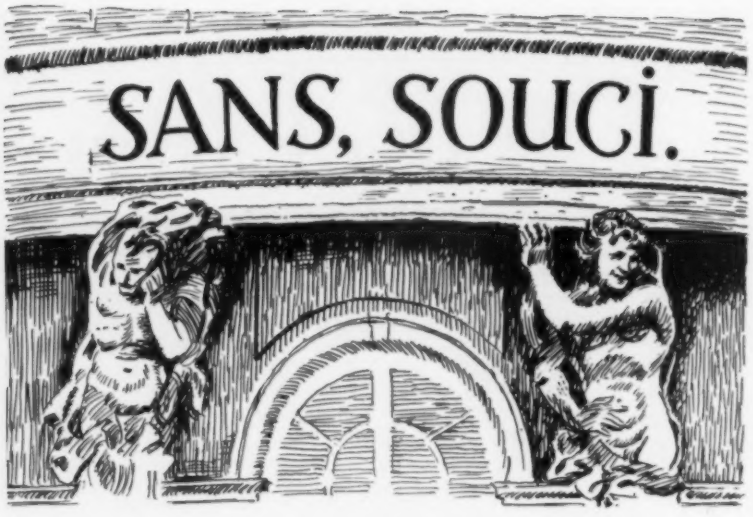
Two Models are available. The Vertical Feed Model adapts to drill presses, vertical tapping machines, etc. The Universal Model for horizontal feeding can be used as a separate unit, or with rotary indexing work tables.

Free Demonstration in Your Plant or Ours... Arrange to visit the Setko plant, or ask for the loan of the new 12 minute 16-mm color movie that gives a "demonstration" in your plant or office. Ask for a copy of Catalog 21, which describes the new Setko System, plus the complete line of Setko standard and special types of set screws.

Set Screw & Mfg. Co.

Pat. No 2,638,945
Other Patents Pending

153 Main Street, Bartlett, Illinois



Ad Libbing by the Editor

Perhaps the most common cause of ulcers, sleepless nights, and irascible temperament is the thought of failure. It stares one in the face throughout life.

Failures in life may be positive or negative. The latter are caused by not doing something that should have been done. In most instances such failures are of small account, although there have been many instances in history where the failure to deliver a message or to follow an order has had disastrous results. Such a failure decided the battle of Waterloo and ended Napoleon's dreams of conquest, his hope of being emperor.

Negative failures, the responsibility of forgetful, procrastinating, weak or lazy beings, are generally of small account. But positive failures, the failures resulting from doing something that was the wrong thing to do, usually have far-reaching effects. Quite naturally so. The positive failures are those made by men of determination, industry and ambition. Such failures are those wherein something is built and then fails. The time and energy that were spent on the project are lost. Often there are accompanying distress and privation. Whereas negative failures are "do-nothing" failures, positive failures are of the "did something that did not work out as expected" type.

Positive failures can be the work only of men who have succeeded sufficiently to command the money required to build things or develop projects. They are the men who have a record of successes behind them. That is why it can be said that the roads to failure are paved with successes. Failure is the opposite of success, just as light is the opposite of darkness. Hence there can be no positive failure without first some successes. The story of Stutz illustrates the point.

Stutz had a highly successful restaurant in lower New York. His customers were mostly ship chandlers, steamship operators, sea captains and stevedores. Everything in this restaurant bespoke simplicity and comfort and Stutz did a thriving business. He was highly successful. His restaurant was usually full.

It is not surprising that Stutz expanded his quarters as much as he could. That was good business. It seemed that the number of customers expanded equally fast. Then Stutz got what he thought was a brilliant idea. All of the tables in Stutz's place were plain rough wood with red-checkered cloths. Some of the tables were round, big enough to seat eight people, but rarely occupied by more than five. Why not put in modern furniture? By using only rectangular tables, he would save much space and would be able to accommodate at least twenty more customers. Stutz went ahead with his idea.

By the time the interior decorators and furniture people got finished, it was impossible to find a trace of the old Stutz place. The best connoisseurs of furniture and furnishing could have found nothing wrong. But the old, familiar customers drifted away,

(Continued on page 356)

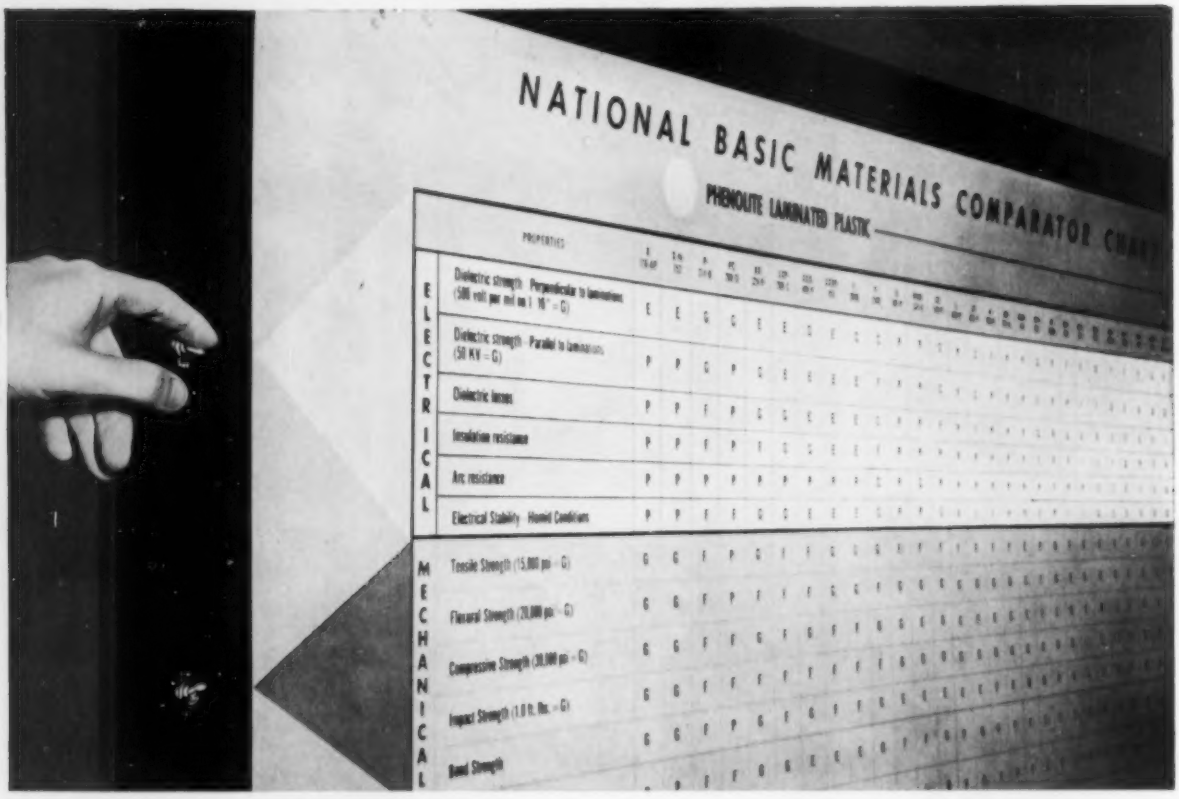
Use WELDED STEEL for Greater Strength with Less Weight!

The 35-Ton Weldment above is the Center Section of a three-section Bed for a large Underdrive Press. This piece, and the units illustrated at the left, are typical of thousands of Steel-Weld Fabricated parts and assemblies produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. It is possible that you, too, could benefit by the economies and other advantages offered by welded steel components in your product. In any type of heavy machinery there are parts and sub-assemblies that can be produced more economically and more satisfactorily in welded steel, because, in weldments you get greater strength with less weight, plus the additional advantages of greater rigidity and predictability. Before you place an order for weldments, you will want to discuss your requirements with Mahon . . . because here is a unique source for welded steel in any form . . . a reliable and responsible source with complete facilities for design engineering, fabricating, machining and assembling . . . a source where advanced fabricating techniques are supplemented by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or, better still, have a Mahon sales engineer call at your convenience.

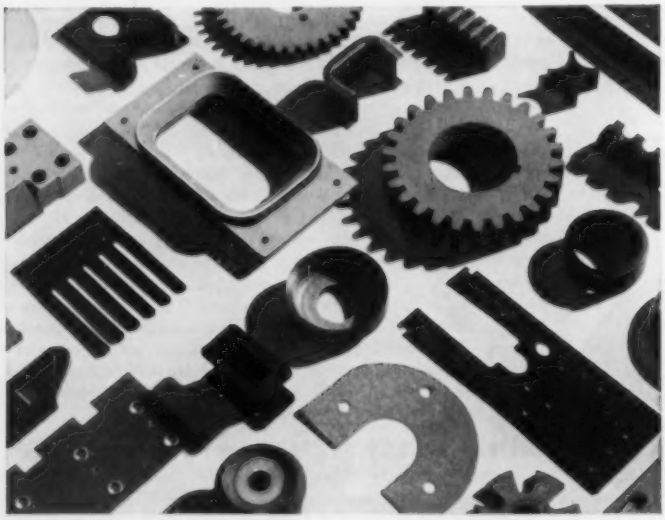
THE R. C. MAHON COMPANY • Detroit 34, Michigan
Sales-Engineering Offices in Detroit, New York and Chicago

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON


NATIONAL BASIC MATERIALS COMPARATOR CHART
PHENOLITE LAMINATED PLASTIC
PROPERTIES
ELECTRICAL
Dielectric strength Perpendicular to laminations (500 volt per mil rate | 16" - G)
Dielectric strength Parallel to laminations (50 KV - G)
Dielectric losses
Insulation resistance
Arc resistance
Electrical Stability Humid Conditions
MECHANICAL
Tensile Strength (15,000 psi - G)
Flexural Strength (20,000 psi - G)
Compressive Strength (30,000 psi - G)
Impact Strength (1.0 ft. lbs. - G)
Bond Strength

COST-CONSCIOUS DESIGN BEGINS WITH "ONE BEST MATERIAL." You'll see this king-size Materials Comparator Chart at the 1957 Design Engineering show in New York. Dramatizing today's problem of materials selection, this device gives a detailed comparison of 31 grades of Vulcanized Fibre and Laminated Plastic—including costs. Property by property each grade is rated so that a choice can be made in a matter of minutes. National's Materials Comparator Chart is also available in handy folder size for personal use. Write to our Wilmington Office for your free copy, or pick one up at the Design Engineering Show, Booth 837. There's no obligation.



DESIGN SOLUTIONS END WITH 100% USABLE PARTS. National's more than 100 grades of basic materials give you greatest selectivity—widest design freedom. Translating your selection into precision-fabricated parts assures the performance you expect from your design. National's fabricating service does this—in the form of 100% usable parts, timed to meet production schedules.

NATIONAL CAN HELP YOU

reduce unit product cost, or improve product performance at no added cost. Here's why . . . You can select the "one best material" from over 100 grades of PHENOLITE®, Vulcanized Fibre and National Nylon—without compromise in properties or cost. You can simplify production and purchasing with the timed delivery of 100% usable parts—from a single, reliable source. You gain competitively with National's new materials and grades—the direct results of programmed materials-research.

You benefit by calling National first. Check Sweet's PD File 2b/Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware, Dept. H.

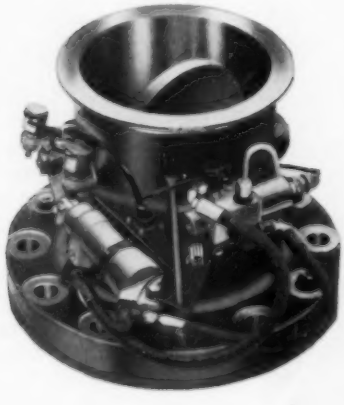
NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE
In Canada: NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

See National at the Design Engineering Show—New York—May 20-23—Booth No. 837

SIX ON A "STICK"

SIX 180 LB. VALVE BODIES SPUNCAST® IN ONE PIECE

Butterfly Valve Body Guided Missile Component type 304, A296-49T CF8 multiple Spuncast at overall saving of 30% over previous fabrication methods.



Here's an opportunity to take advantage of one of the most cost saving techniques in modern casting practice—*ESCO* Spuncast Multiple Casting. You can cut fabrication and machining time to a minimum, save on material costs with definite improvement in quality.

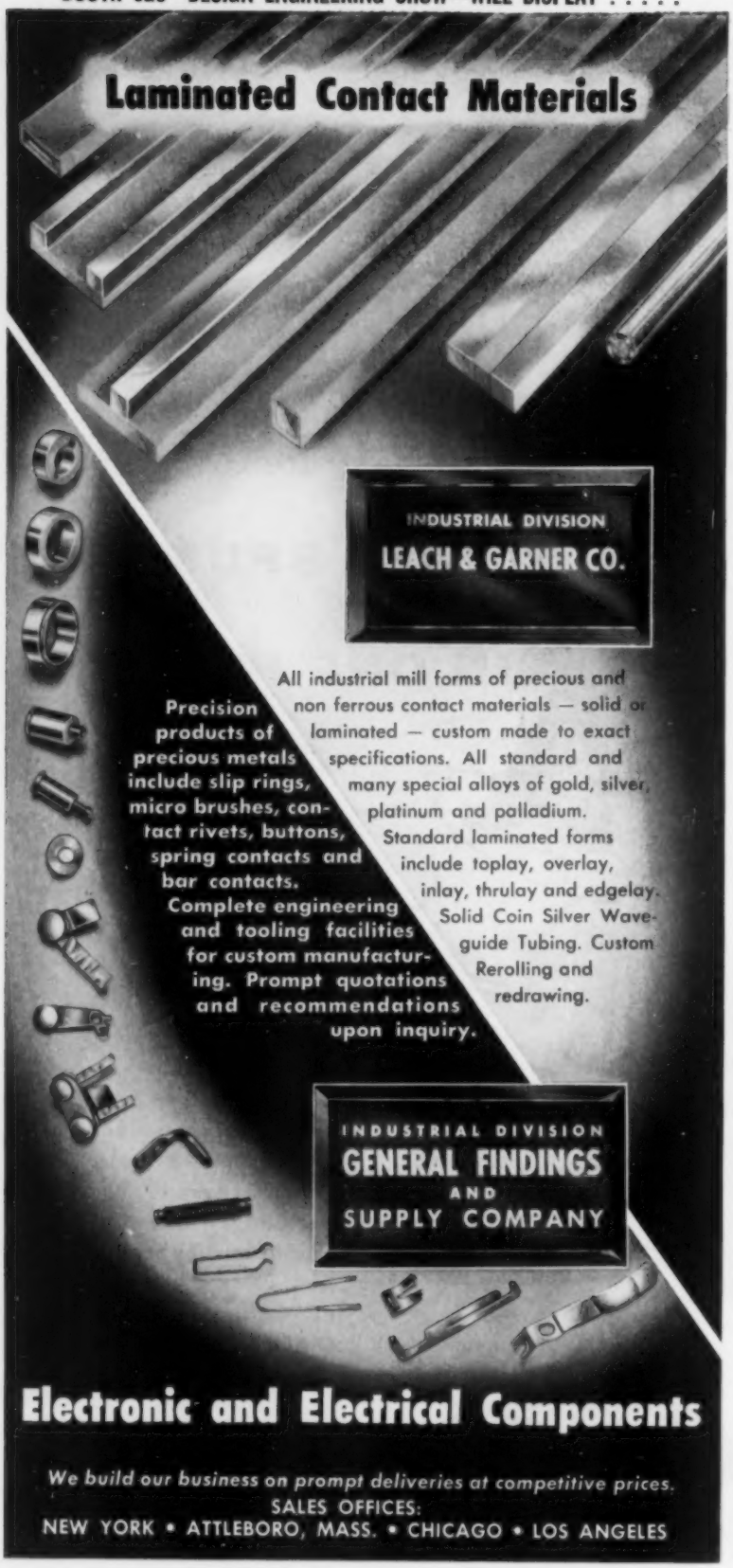
Whether your problem is one of heat, corrosion, impact, abrasion or alloy availability, the *ESCO* engineering staff will help you plan for greater savings in time, material and money with *ESCO* SPUNCAST.

ESCO

ELECTRIC STEEL FOUNDRY COMPANY

2177 N. W. 25TH AVE. • PORTLAND 10, OREGON
MFG. PLANTS AT PORTLAND, ORE. AND DANVILLE, ILL.
Offices in Most Principal Cities
ESCO INTERNATIONAL, NEW YORK, N. Y.
IN CANADA ESCO LIMITED

"BOOTH 526—DESIGN ENGINEERING SHOW—WILL DISPLAY . . . . ."


Laminated Contact Materials
INDUSTRIAL DIVISION
LEACH & GARNER CO.
All industrial mill forms of precious and non ferrous contact materials — solid or laminated — custom made to exact specifications. All standard and many special alloys of gold, silver, platinum and palladium. Standard laminated forms include toplay, overlay, inlay, thrulay and edgelay. Solid Coin Silver Waveguide Tubing. Custom Rerolling and redrawing.
Precision products of precious metals include slip rings, micro brushes, contact rivets, buttons, spring contacts and bar contacts. Complete engineering and tooling facilities for custom manufacturing. Prompt quotations and recommendations upon inquiry.
INDUSTRIAL DIVISION
GENERAL FINDINGS
AND
SUPPLY COMPANY
Electronic and Electrical Components
We build our business on prompt deliveries at competitive prices.
SALES OFFICES:
NEW YORK • ATTLEBORO, MASS. • CHICAGO • LOS ANGELES

Sans, Souci .....continued

and no new ones came to replace them. The improvement was a failure.

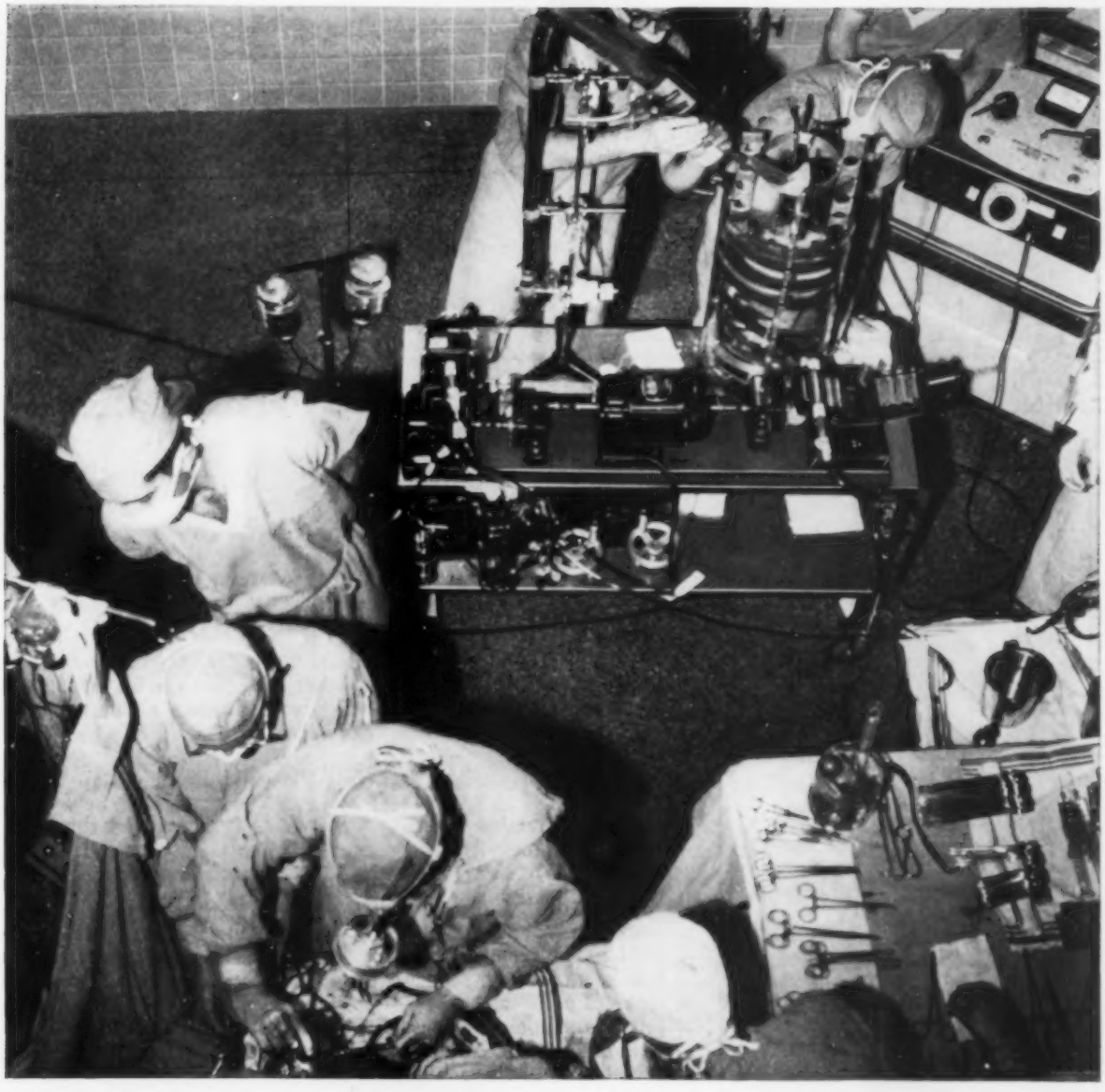
Finally Stutz succeeded in getting into a conversation with one of his old customers and got him to tell why he no longer came around.

"Mr. Stutz," said the ex-customer, "All of us ate at your place for several reasons. We did not have to feel afraid of messing up the table cloth. We drank our beer off the bare table tops and recognized all the burns and scratches on them as old friends. The chairs were big and comfortable. The place was not crowded and we did not feel that we had to get out in a hurry. Everybody knew everybody else. But now you have all swanky furniture and those frail-looking chairs that us 200-pounders are afraid to put our fat behinds on, and the white table cloths look too damn clean, the waiters breathe down our necks. We don't like it, so we don't come around any more."

To Mr. Stutz's credit, he rushed over to the secondhand furniture man to whom he had sold all the old stuff and swapped it back for the new stuff. He changed the place to look as near as possible like its former self. But it was many months before the old crowd came back. Some of them never did. Like Mark Twain's cat, who sat on a hot stove lid once, and thereafter never sat on a stove lid again, hot or cold, they were "once burned, hence twice shy."

It was success that caused Stutz to make that failure. His past successes convinced him that he knew what the result would be when he refurbished his restaurant. He had succeeded in building a business that filled his place at every meal. That created in him the ambition to build a bigger and better "Stutz." But he was wrong and failed. His long road of successes ended in relative failure, because he had to go backward to hold his own.

Businesses face this same problem many times daily. To expand merely to grow bigger is usually disastrous. Growth that renders better service and more of it is the only kind that can be truly successful. Merely multiplying the physical factors involved in a business often eventually brings in other elements that first merely counteract, but eventually overwhelm, the fundamentals that had made the business a success. —G. F. N.



Leland Motors circulate blood for "stopped heart" surgery

Combining their knowledge and skills the University of Minnesota and Sigmamotor, Inc., have perfected an ingenious heart-lung machine which permits a surgeon to stop a beating heart, open it and then work inside for extended periods of time.

The new equipment, representing a great advance in direct-vision, intracardiac surgery, circulates the patient's blood through an oxygenator and back through the patient, completely by-passing the stilled heart. *The circulating pumps are powered by a ⅓ hp Leland explosion-proof motor.*

Next time *you* need a motor you can depend on—look to Leland. You'll find Leland knows how to make motors to answer your specific needs. For more information on the complete line of Leland motors and generators, write the address below today.

Leland explosion-proof motor, capacitor-start, induction-run. 115/230V, 4-pole double shaft. Underwriters Listed Class I, Group C (for atmospheres containing ethyl ether vapors, ethylene, or cyclopropane).

Another AMF Product
LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Dayton 1, Ohio
Division of AMERICAN MACHINE & FOUNDRY COMPANY

Visit us at Booth 1313
Design Engineering Show

JOIN WITH HANDY & HARMAN SILVER BRAZING FOR PERMANENT PROFIT

Before, sprocket was machined and hobbed from solid metal, then welded. Now, three stampings are EASY-FLO-brazed to turned hub.

Result—sprocket made stronger in less time, with less metal.

Visit us at Booth 1213 Design Engineering Show New York Coliseum May 20-23

SEE:

NEW ALUMINUM BRAZING ALLOY

HANDY HI-TEMP FOR HIGH-TEMPERATURE BRAZING

PRODUCTION LINE BRAZING DEMONSTRATION

Clever, these Design Engineers!

The cleverest designers of all are those who know that silver alloy brazing, specified as the joining method at the *design stage*, can be of great value. The benefits that go hand in hand with brazing—of cost, of time, of labor, of product superiority, warrant consideration from the start.

Examples of how design for brazing simplifies production and improves the product are numerous . . . to give you an idea of what can be saved through Handy & Harman silver alloy brazing with EASY-FLO 45, take a look at this:

Triple Sprocket for Self-Propelled Combine

Originally, double sprocket was bored, turned and hobbed from solid stock; small sprocket and hub were turned from single piece of bar stock. Large sprocket was then welded to hub as shown.

Redesigned for EASY-FLO brazing, large and small sprockets are blanked from 1/2″ plate and bored and hobbed in groups; hub is turned from much smaller diameter bar stock. Three rings of 1/16″ EASY-FLO wire join the entire assembly. All joints are Handy-Fluxed. Large sprockets and hub are jigged with one preplaced ring of EASY-FLO around hub above each sprocket and induction-brazed in 30 seconds. Third EASY-FLO ring brazes small sprocket to hub end in 17 seconds. Total: 47 seconds for completed assembly. Results: Lower over-all production costs due to savings in metal, machining and joining time. A stronger sprocket due to full-area penetration of the alloy.

This is just one example of the benefits enjoyed with one Handy & Harman alloy and brazing method. We'll be happy indeed to talk to you about all kinds of silver brazing alloys and their attendant benefits. We have found that if we join forces right at the start, the results are right . . . all the way. Just call us.

Your NO. 1 Source of Supply and Authority on Silver Brazing Alloys

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

OFFICES and PLANTS
BRIDGEPORT, CONN.
PROVIDENCE, R. I.
CHICAGO, ILL.
CLEVELAND, OHIO
DETROIT, MICH.
LOS ANGELES, CALIF.
TORONTO, CANADA
MONTREAL, CANADA

CHOICE OF BUILT-IN VALVES GIVES CONTROL FLEXIBILITY

SINGLE AIR CONNECTION SIMPLIFIES INSTALLATION

RUGGED CONSTRUCTION ASSURES LONG LIFE

125 BELLOWS SALES AND SERVICE FIELD ENGINEERS

■ There are one or more Bellows Field Engineers in every industrial area of the United States and Canada. They will be happy to work with you in applying "Controlled-Air-Power" to your machine designs. They are listed in their local phone directories under "The Bellows Co."

758-B

Four reasons why THE BELLOWS AIR MOTOR stands first with design engineers

In designing for air cylinder operation the engineer wants first of all sure, positive control, easily interlocked to related machine movements. **He has it in The Bellows Air Motor.**

He wants simple installation, uncomplicated by cumbersome piping. **He has it in The Bellows Air Motor.**

He wants rugged construction — an air cylinder that will stand up day in and day out with minimum requirements for service and repairs. **He has it in The Bellows Air Motor.**

But he also wants the knowledge, if service should ever be needed, that it is quickly available wherever his machine may go. **He has it in The Bellows Air Motor.**

The Bellows Co.

AKRON 9, OHIO

This free booklet offers interesting data for the design engineer. Write for it today. Address Dept, PE557. Ask for Bulletin BM-25. The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd.

new glamour in the kitchen

with NICKELOID METALS

Pre-Plated Metals Offer Design Freedom, Production Savings!

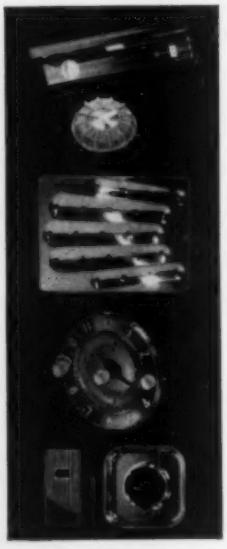
Beautiful, easy-to-clean built-in range by Oakland Foundry, Belleville, Ill., features Nickeloid pre-plated chrome steel, satin finish, for door panels, oven, burner inserts, control panel and hood.

More Than A Metal—It's A Method

Oakland Foundry, Belleville, Ill., a leading manufacturer of electric ranges, puts it this way: "We were unable to fabricate the alternate material without new tooling. Nickeloid Metals have increased our production, reduced rejects and lowered the costs of our product".

If *you* are caught between increasing manufacturing costs and the constant consumer demands for new and improved products, consider Nickeloid *Pre-Finished* Metals. An extremely versatile design material, they fit right in with standard production techniques, without major retooling — lower manufacturing costs and equipment investment because they require no cleaning, post-plating, polishing. You just fabricate and assemble — *and save!*

Choose from beautiful, durable finishes of chrome, nickel, copper or brass on steel, zinc, copper, brass and aluminum. Sheets, strips, coils.



NICKELOID METALS SINCE 1898 N®M

See NICKELOID—Booth 1307
Design Engineering Show
New York Coliseum

AMERICAN NICKELOID CO.
PERU 4, ILLINOIS

Paid What You're Worth?

(Continued from page 206)

simply by reorganization. Latest reports indicate that the average cost of obtaining an experienced engineer for defense work is approaching $5000. Wouldn't it be better if the company doing both industry and defense work put on a clerk in industry and transfer a trained technical man from the industry operations to defense?

From my experience with engineers I know that they detest unionization. On the other hand, failure of engineering management to do something about this situation is forcing engineers to unionize. Engineering management has got to get on the ball and start to move or unionization will be so advanced that it can't be stopped.

and job evaluation?

TO THE EDITOR

. . . at the present time one of our major problems in evaluating salaries is in job evaluation. It is difficult to compare our engineers' salaries with those in other industries since in many instances the man with whom you discuss the situation is really only familiar with the salary and not the engineer's function within the Engineering Department. For example, on one occasion we found ourselves comparing the salary of a Junior Engineer, as we classify the man, with a Junior Engineer in another industry, who actually is doing work that we could classify as a Senior Engineer. This has created much confusion . . .

professional development?

TO THE EDITOR

The question, "Are You Paid What You're Worth?" has been answered by at least one group. In a survey of its members the Chemical Industry Association of New York found that those in the upper percentiles felt they were equitably paid, some even indicated they considered themselves overpaid. Those in the lower brackets felt they were underpaid. Of course, there were random variations in the

(Continued on page 363)

Imagine a mile-wide ball with surface finish accurate to within 1/16"

If Hoover could make this giant bearing ball—one mile in diameter—and maintain Hoover quality of precision manufacture, the immense sphere would be so smooth that surface finish would be accurate to within 1/16 inch!

In actual terms, the surface smoothness of a Hoover Ball is measured on a micro-inch basis. Roundness and diameter are held within 25 millionths of an inch. Microscopic precision, both in smoothness and spherical accuracy, means quality in Hoover *Micro-Velvet* Lapped Balls.

Equipment which will measure surface quality to a fraction of one millionth of an inch is used to check and re-check Hoover Balls. A perfectly matched set of *Micro-Velvet* Balls goes in each bearing.

These precision-made balls team up with the ultra-smoothness and minutely exact curvature perfection of famous *Hoover Honed* Raceways.

The result . . . equalized load, high capacity, and quiet operation, assuring superior operating performance and long life.

Investigate Hoover's complete line of balls, made in many metals, as well as light, medium and heavy series ball bearings. Engineering assistance is readily available to manufacturers. Write for information.

HOOVER HINTS:

Factors Involved In Bearing Selection

Application is the key to bearing selection. The importance of a bearing's characteristics is relative to the job it must do. Usually one of the most important factors is the capacity or load-carrying ability. Also important in many applications is the type of loading—thrust, radial or combined . . . the amount of friction involved . . . the ease of assembling a bearing into a unit . . . the danger of misalignment . . . the limiting maximum speed.

All types of anti-friction bearings are concisely compared and analyzed from an engineer's standpoint in "Engineer's Handi-Book of Anti-Friction Bearings." Send for yours now.

Hoover Ball and Bearing Company,
Ann Arbor, Michigan.

Mail my copy of "Engineer's Handi-Book of Anti-Friction Bearings."

Name _____

Title _____

Company _____

Address _____

City _____ State _____

9

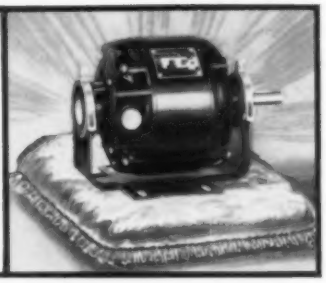
hoover

BALL AND BEARING COMPANY, ANN ARBOR, MICHIGAN

Hoover Honed and *Micro-Velvet* are Hoover Trademarks.

tailor-made for You

. . . and every one a perfect fit



No Sir, no ready-made here. Emerson-Electric motors are custom-engineered for your product . . . *designed* for you, *produced* for you and *priced* for you. It is no longer necessary to design your product around a *standard* motor. Emerson-Electric engineers will work with you through every stage of development. You get the product you want with a motor that EXACTLY suits your purposes . . . a custom-engineered motor at *standard motor prices.* Call, wire or write Dept. M-50 today, The Emerson Electric Mfg. Co., St. Louis 21, Mo.

EMERSON-ELECTRIC
of St. Louis

Since 1890

replies. One can reasonably expect that a survey of any other occupation having a range of pay rates would bring forth a similar response.

In the final analysis, there can be no sound basis for equitable reimbursement. The products of the professions are of such an intangible nature that salaries must necessarily be set by devices which have only an indirect relationship to the particular contributions of each individual. Unfortunately, the standard for measuring success and achievement in Western culture is materialistic. As a result, dissatisfactions arise more because of comparison with others than because of real hardships. A low pay scale is taken as indicative of limited attainment.

Salary studies like this one confine their attention to:

1. Absolute increase and rate of change of engineers' pay levels compared with gross national income and with certain non-professional groups.
2. Spread in income levels of engineers.
3. Increase in income with growing maturity and experience.

The first type of comparison overlooks the fundamental nature of increasing productivity in America. It has a risen because of the phenomenal growth of mass-production industries. We are not injurying the better-paid professional people by increasing the average income of the major portion of workers. One might fairly argue that the average income in 1939 was too

(Continued on page 366)

"He hasn't let go of it since he won it last year—"

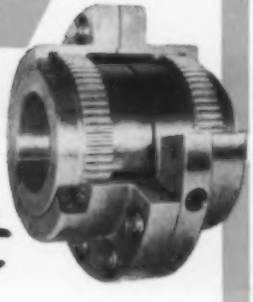
Waldron couplings on a fan drive of jacket water coolers.

by specifying

WALDRON

Gear Couplings

you get



STRENGTH — Hubs and cover sleeves for sizes 1¼ A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

RELIABILITY — There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is positioned where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

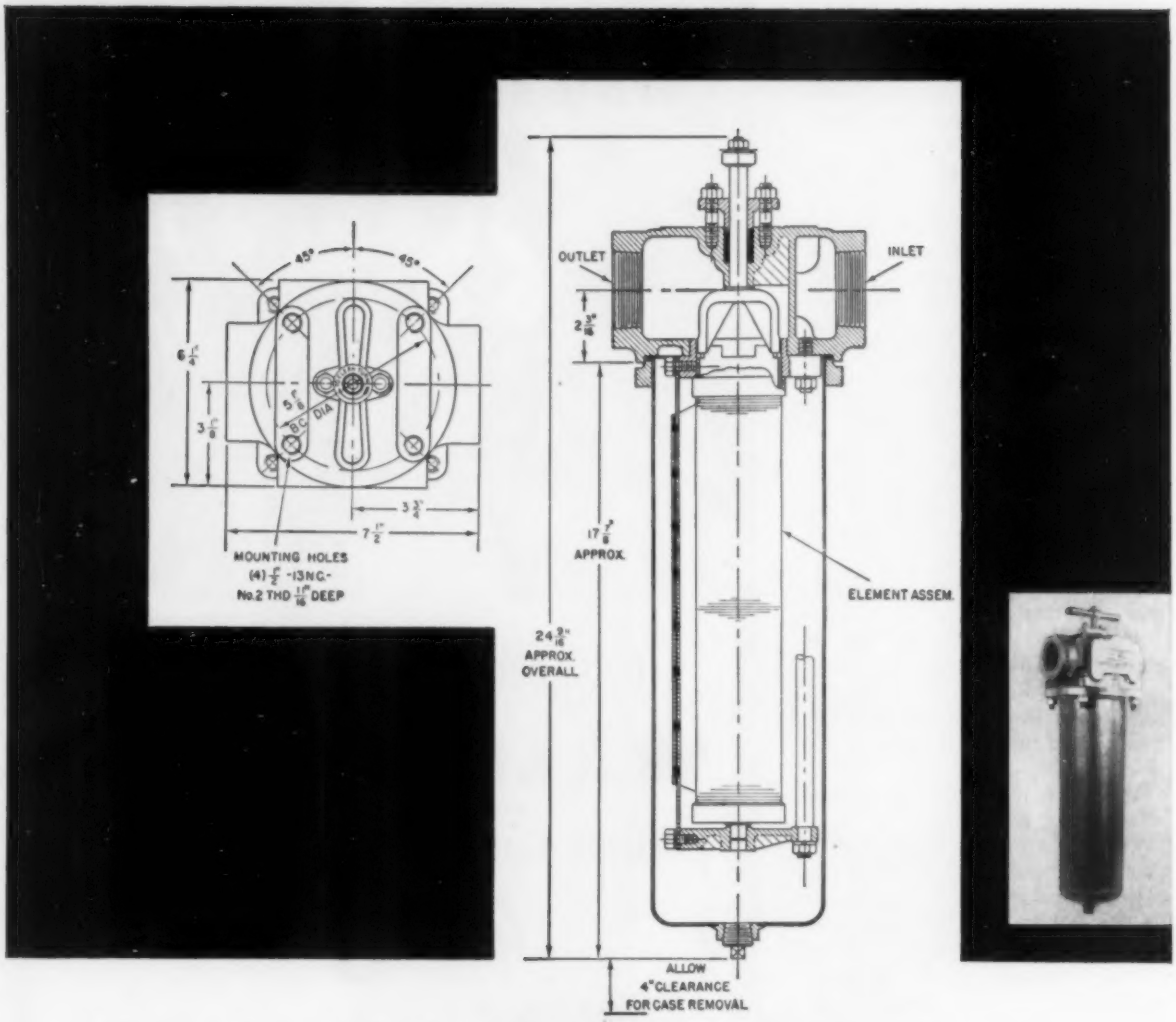
SERVICE — Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

▸ Ask for Catalog 57

JOHN **WALDRON** CORP.

NEW BRUNSWICK, NEW JERSEY

Representatives In Principal Cities



Your "special" filtration problems can be solved by standard Purolator filters

FOR EXAMPLE... This one standard Purolator filter is exactly right for all these "special" filtration problems:

inks, paints,
varnishes, machine tool coolants,
greases, vitamin solutions,
as well as fuel and lube oils.

This filter's specifications may recommend it for a problem of yours. If not, you're almost certain to find a standard Purolator filter that does meet your needs—exactly.

SPECIFICATIONS... This is Purolator filter model G-141J with simplex full flow metal element oil strainers. It is designed for primary or first stage filtration and can be installed on pressure or suction side of pump. Recommended for maximum capacities of 40 to 80 GPM, dependent on spacing which varies from .003 to .010. Relief valves set from 10-12 to 50 PSI are incorporated in several models. Motor driven knife blade to clean element can be furnished whenever conditions make manual rotation impractical. Head is made of high tensile cast iron, body of drawn steel. Inlet and outlet connections are 2", drain plugs are provided. Maximum pressure: 125 PSI; weight: 37 lbs.

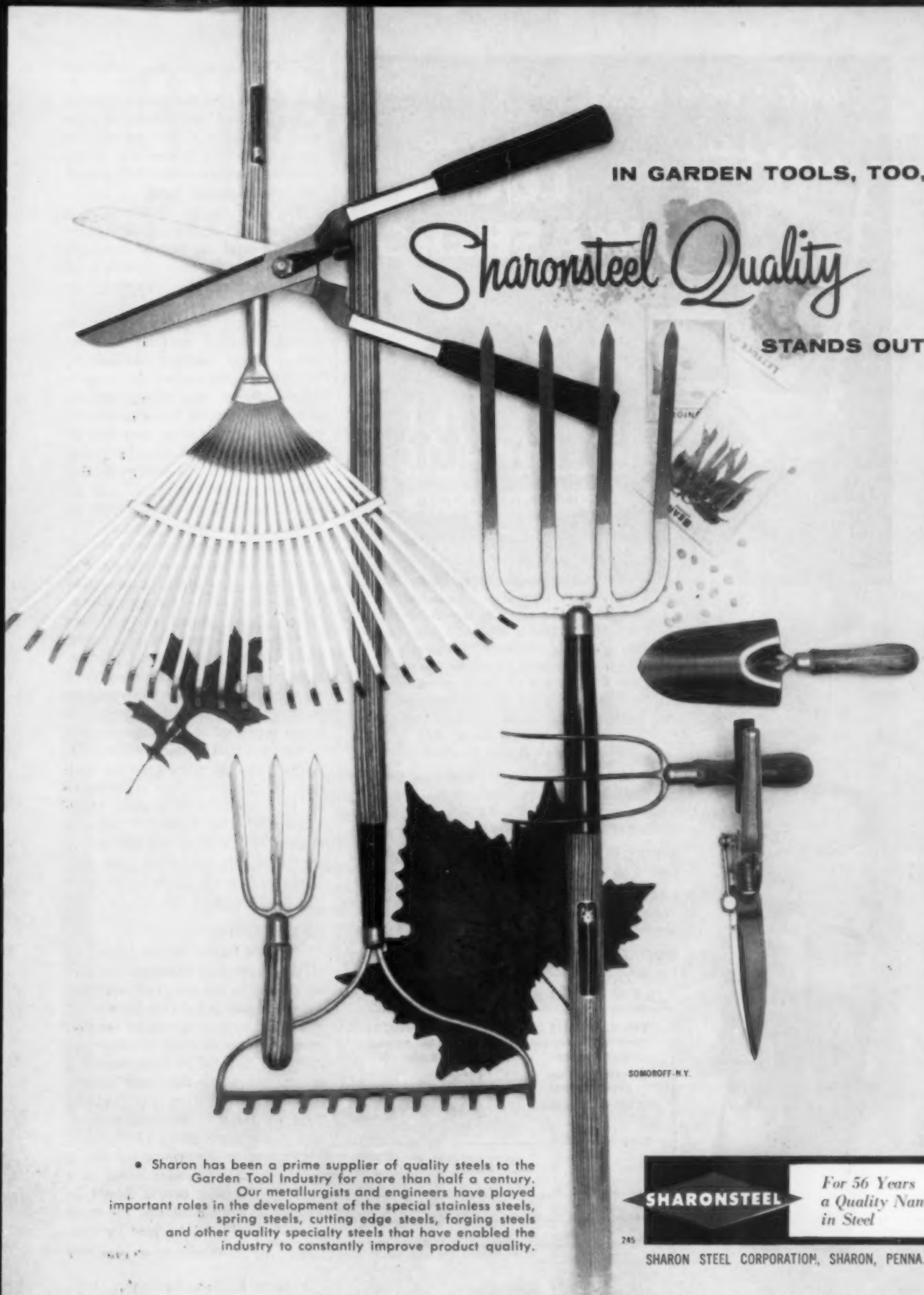
Remember, if these specifications don't match your needs, there's probably a filter that does at Purolator. Find out. Send in your problem.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada



IN GARDEN TOOLS, TOO,

Sharonsteel Quality

STANDS OUT

SOMOROFF-N.Y.

• Sharon has been a prime supplier of quality steels to the Garden Tool Industry for more than half a century. Our metallurgists and engineers have played important roles in the development of the special stainless steels, spring steels, cutting edge steels, forging steels and other quality specialty steels that have enabled the industry to constantly improve product quality.

SHARONSTEEL

For 56 Years a Quality Name in Steel

245

SHARON STEEL CORPORATION, SHARON, PENNA.

CHICAGO, CINCINNATI, CLEVELAND, DAYTON, DETROIT, GRAND RAPIDS, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, ROCHESTER, SAN FRANCISCO, SHARON, MONTREAL, TORONTO

when you need...

HELICAL SPRING

LOCK WASHERS

Pronto!

Call on Garrett

OF PHILADELPHIA

"D" & TIOGA STREETS • PHILA. 34, PA.
GARFIELD 6-4000

Garrett's complete stock of dies guarantees immediate delivery regardless of size or quantity from the largest line of Helical Spring Lock Washers available anywhere. Precision-made with "controlled" tension for tighter assemblies, your specifications can be met in carbon steel, stainless steel, aluminum-zinc, phosphor-bronze and K-monel.

Garrett Manufactures the World's Most Complete Line of Washers

FLAT WASHERS—Made to meet new ASA and SAE standards . . . available in steel, brass, bronze, monel, aluminum, and stainless steel . . . finished to your specifications.

METAL STAMPINGS—Made to your specifications on high-speed production presses.

SPRING WASHERS—Belleville, Bevel, 3-Wave, 4-Wave and other Spring Washers of special design.

HOSE CLAMPS—Multi-clamp, Auto-Seal and Spring-Grip Hose Clamps.

SEND FOR LITERATURE

GEO. K. GARRETT CO., D & TIOGA STS., PHILA. 34
Please send, without obligation, literature on the following:

- ☐ FLAT WASHERS
- ☐ HELICAL SPRING LOCK WASHERS
- ☐ SPRING WASHERS
- ☐ HOSE CLAMPS
- ☐ STAMPINGS
- ☐ GARRETT STATISTICAL QUALITY CONTROL

Name_____

Title_____

Company_____

Address_____

City_____ State_____ Key No PE-5

low—not because the people were inadequately paid, but because as a nation we had not yet set up our factories for the production of the many luxuries now considered necessities by the average family.

The other two considerations given above are really significant. Against the background of our current standards, are our salary increases of such a nature as to stimulate growth of our engineers?

Salaries are the result of an extremely complex interplay of many factors. High starting salaries for graduate engineers reflect the competition for such men. Since without much experience or specialization engineers up to five years from first degree are more or less interchangeable there is considerable fluidity, so that price is sensitive to supply and demand. In 1939, an excess supply resulted in a low starting salary.

With increasing experience, the salary increases come about as a result of some sense of what is the top salary for the man's role in the organization. In most fields, salaried personnel have experienced increases less than the increase in the gross national product. If this situation is to be changed, there must be a nation-wide acceptance of such rate of increase of income. This would apply not only to engineers but to teachers, civil servants, white-collar workers, etc. In order to avoid inflation, the true production of the country as a whole must increase correspondingly. The possibility and the desirability of maintaining such steady growth in our production and consumption of goods is one of the most vexing questions of our day . . .

TO THE EDITOR

. . . I do believe in the setting up of maximum and minimum salaries for all jobs by the use of an equation, however, I do not feel that the amount of a merit increase should be awarded on such a fixed method . . . increases should be awarded to those deserving in amounts which they have earned, not in regulated steps. For example, there are many times when a supervisor would like to give a $50 increase. This might be somewhere between a one or two step increase based on a fixed formula . . . people should be handled as individuals and the exact amount should not be fixed by com-

(Continued on page 370)

TDA® BRAKES

if it rotates...we can control it!

Ultra-Simplicity in a new, compact brake of exceptionally high torque output!

new "VEE" brake

This new brake offers important control advantages to virtually every industry. It is already proving its worth in many demanding applications in the farm equipment and materials handling fields.

The "VEE" Brake is extremely simple in design—only six parts. A new design concept achieves an exceptionally high torque output with extremely simple installation. The unique wedge action makes it self-energizing in both directions. Result: An exceptionally compact, easily assembled brake with stopping power to spare.

Cooler running is assured with a proportionately greater drum-swept area. This, combined with bonded high-density linings, provides longer life. Actuation is mechanical and may be power-applied.

Simple installation and adjustment! The "VEE" Brake can be completely assembled and then inserted in its enclosure. This eliminates "blind" assembly of the parts. Adjustment can be accomplished by changing the length of the pull rod. Maintenance is quick and easy . . . just minutes to take apart and reassemble.

For every industrial, agricultural or automotive application where braking is required!

TDA Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

©1956, RS&A Company

TIMKEN Detroit BRAKES
ROCKWELL SPRING AND AXLE COMPANY
Accepted TDA Standard

Timken-Detroit Brake Division
Rockwell Spring & Axle Company
Dept. PE-57, Ashtabula, Ohio

Please send me further information on your "VEE" Brake.

Name _____ POSITION

Company _____

Address _____

City _____ State _____

The PUSH behind the Sidewinder's Sting!

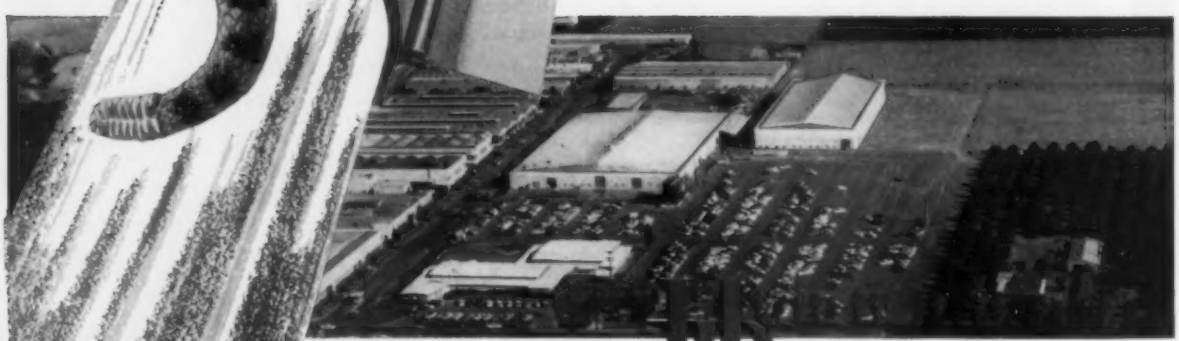
...A development of Hunter Douglas

Effective at altitudes up to 50,000 feet, the Navy's air-to-air guided missile, SIDEWINDER, is a rugged, sensitive and reliable weapon. Encompassed in its incredibly small 5" diameter and 9'5" length are all necessary propulsion and guiding equipment plus a deadly warhead. Surprisingly, the SIDEWINDER is unusually economical; produced at a cost comparable to a load of aircraft cannon bullets... *an economy resulting directly from Hunter Douglas technical achievements in the field of cold forging!*

The major problems of producing a light, strong motor tube meeting precision tolerances required in this type of propulsion unit were solved by Hunter Douglas. The SIDEWINDER motor tube was produced as a single precision aluminum cold forging integrating the tube and wing supporting channel ring section, eliminating costly assembly operations and alignment difficulties. The tube is typically straight within .020" TIR, I.D. within .006", wall thickness within .0015" and yield strength of 72,000 psi minimum.

Completion of Hunter Douglas experimental cold forging techniques helped pave the way for mass production of the SIDEWINDER. Today, Hunter Douglas is the only successful producer of this complex cold forged component and is the prime contractor to the U.S. Navy, delivering the completely assembled SIDEWINDER motor, ready for final addition of propellant, warhead and guidance unit.

Behind this notable Hunter Douglas achievement stands a strong integrated business structure combining technical resources, manufacturing facilities and the coördinated staff to see all jobs "WELL DONE."



Hunter Douglas Aluminum

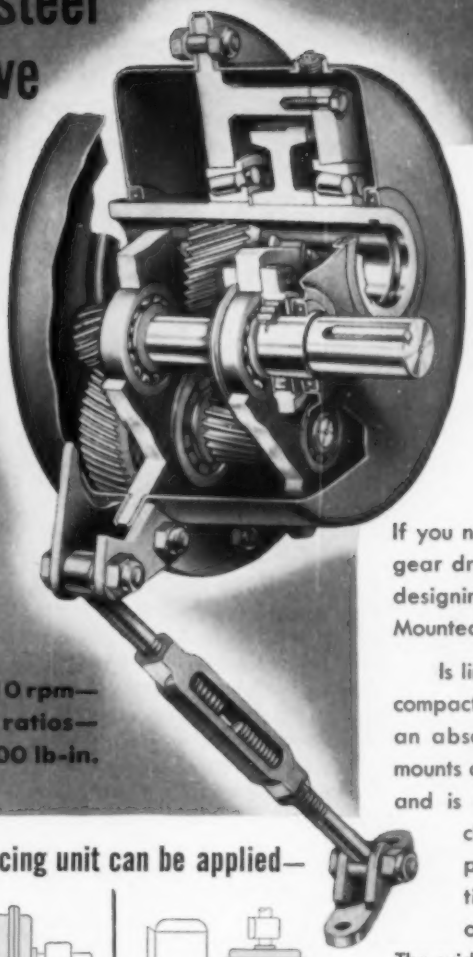
Division of

BRIDGEPORT BRASS COMPANY

Dept. PE-5, Riverside, California, Telephone OVerland 3-3030

The FALK all-steel Shaft Mounted Drive

- *Versatile*
- *Efficient*
- *Economical*
- *Compact*



SIX SIZES—½ TO 30 HP—420 to 10 rpm—single and two double reduction ratios—output torque ratings up to 21,000 lb-in.

To Design men:

If you need an efficient, economical gear drive for the machine you are designing, the all-steel FALK Shaft Mounted Drive is your answer.

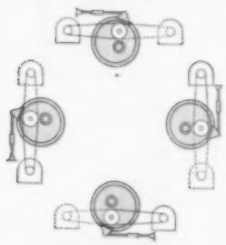
Is limited space a problem? This compact speed-reducing unit requires an absolute minimum of space. It mounts directly onto the driven shaft, and is driven through a V-belt or chain from any convenient power source. Unit can be positioned in countless ways, some of which are sketched below. The widest choice of output speeds is made possible by varying driving sheaves or sprockets.

Designed and geared by FALK, recognized leader in gear manufacture, this Shaft Mounted Drive will be a dependable component of your machine.

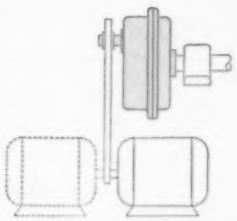
★

FALK Shaft Mounted Drives are available from factory stocks *from coast to coast*. See your Falk Representative—or write direct for copy of **Bulletin 7101.**

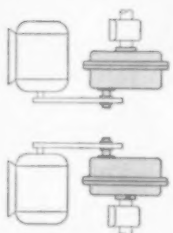
A few of the many ways this reducing unit can be applied—



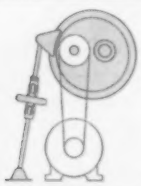
ANY POSITION



MOTOR EXTENDED
—or below the unit

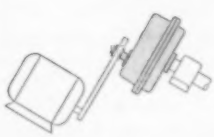


VERTICAL—UP or DOWN



VARIABLE SPEEDS...
through use of variable-pitch sheaves—automatic belt adjustment with tie-rod adjustment

OVERLOAD RELEASE...
that will slacken belts and cut off power if overload occurs



INCLINED SHAFT...
Any standard unit can be mounted in vertical or inclined position by a simple rearrangement of oil drains

THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.

Representatives and Distributors in Most Principal Cities

Manufacturers of

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

...a good name in industry

How Alcoa Aluminum Fasteners make good windows even better

MEETS AWMA STANDARDS!

You can meet the highest standards of quality and the specifications of the AWMA (Aluminum Window Manufacturers Association) for prime windows of aluminum when you assemble with Alcoa® Aluminum Fasteners. Perfect color match and protection against both galvanic and atmospheric corrosion make for lasting good looks . . . consumer satisfaction. Complete stocks carried by your local Alcoa distributor fill every requirement. He is listed in the Yellow Pages of your telephone directory.

ALCOA ALUMINUM FASTENERS
©ALCOA

Your Guide to the Best in Aluminum Value

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

Fill out coupon for facts, samples

Aluminum Company of America
2247-E Alcoa Bldg., Pittsburgh 19, Pa.
Gentlemen: Please send complete specification data and samples of Alcoa Aluminum Fasteners.

Name _____
Title _____
Company _____
Address _____

pany policy, though it could be within ranges as suggested by the article.

TO THE EDITOR

In the second part of his article, Dr. Peck was concerned with salary growth and the administration of that salary growth. However, he based his analysis on the assumption that the salary relationships which existed at one point in time between the salaries of engineers at various merit levels and various experience levels (we call these salary-structure curves) could be used to predict salaries in the future. If the salary administration policies are in equilibrium, i.e., not changing from year to year, then the salary-structure curve can be used to predict salary growth (if inflation is ignored or accounted for).

Now it happens that we have had an opportunity to conduct some statistical studies on the actual growth rates of particular groups of engineers (following the salary history of individuals). Even when these growth rates are corrected for the changing salaries paid new engineers, we have discovered that the average growth rate is substantially greater than that predicted by the slope of the salary-structure curve.

For many years, we have also made the assumption that Dr. Peck made in this article. We have since learned that this assumption is so much in eror that it leads to many conclusions which are very seriously in error. Anyone who is concerned with the trends in engineer's salaries simply must resist the temptation to use a salary-structure curve as if it were a salary-growth curve. Otherwise, I don't believe he will ever come to an accurate understanding of the true circumstances. In the light of the facts as we understand them, it would be disastrous to base a salary administration policy on a salary-structure curve.

What Helps Income?

TO THE EDITOR:

I was able to use the graph and facts on salaries in discussing "Electrical Engineering as a Career" with 52 of the local high-school students during a Career Guidance Day. My emotions were somewhat mixed as to the article, since I came through the

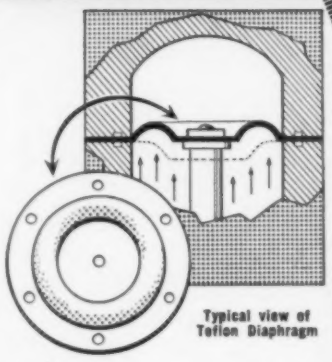
(Continued on page 374)

for NEW PERSPECTIVES... let SPARTA help you put ideas to work with

CUSTOM MOLDED **TEFLON***

*DuPont's Tetrafluoroethylene Resin

IN THIN SECTIONS AND SHAPES!



Typical view of Teflon Diaphragm

Look to Sparta, pioneers in the development of custom molded Teflon parts (Pat. No. 2,781,552). Our highly trained Fluorocarbon engineering staff... modern manufacturing methods, are available to help you solve any design problems you may be experiencing with ordinary flexible materials.

The unique combination of properties of Teflon offers economical and product improvement opportunities never before possible.

When you think of TEFLON think of SPARTA!

We carry a COMPLETE STOCK of all standard Teflon products.

WRITE for complete data, prices, properties and applications without cost or obligation.

Dept. PE

The first cost can be the least . . . if it is the last cost.

SPARTA MANUFACTURING CO.
Division of United States Ceramic Tile Co.
DOVER, OHIO PHONE 4-2380

WESTERN DISTRICT OFFICE
Phone: ANGELUS 3-6359 Los Angeles, California

WHY PAY MORE
for specials, when you can get what you need FROM STOCK?

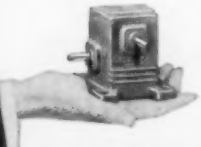
Design around BOSTON Gear 100 SERIES SPEED REDUCERS

1605 types and ratios **FROM STOCK**

And now MORE SIZES in small REDUCTORS

Meet increasing needs for smaller units in Horizontal Right Angle Drive models. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

Catalog No. 56 lists full specifications, includes 50 pages of engineering data to aid in selection and application.



CALL YOUR BOSTON Gear DISTRIBUTOR

Visit BOSTON GEAR Booth No. 206 at the DESIGN ENGINEERING SHOW

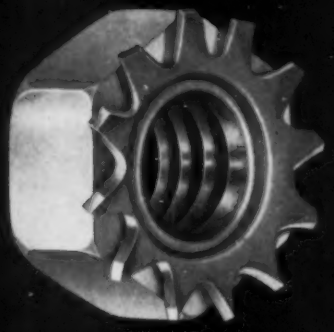
handle

One Unit

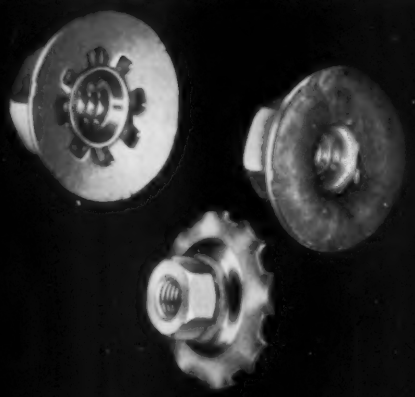
instead of

Two or More

cut costs instantly!



KEPS® pre-assembled nut and Shakeproof® Lock Washer



Each of these Keps replaces three separate units for greater savings: Dished and Domed Washer Keps for extra strength and holespanning; Sealing Keps for sealing out water, oil, gasoline or air.

• Keps end separate nut and lock washer handling • Often eliminate many extra fastening parts • Provide positive locking action, maximum product protection • Washers can't get lost, mismatched or forgotten • Available in broad range of styles, materials and sizes.

Write for Sample Kit Containing Variety of Keps

SHAKEPROOF

"FASTENING HEADQUARTERS"®

DIVISION OF ILLINOIS TOOL WORKS

St. Charles Road, Elgin, Illinois • Offices In Principal Cities

In Canada: SHAKEPROOF-FASTEX, Division of Canada Illinois Tools, Ltd., Toronto, Ontario

i t w

use Porcelain Enamel

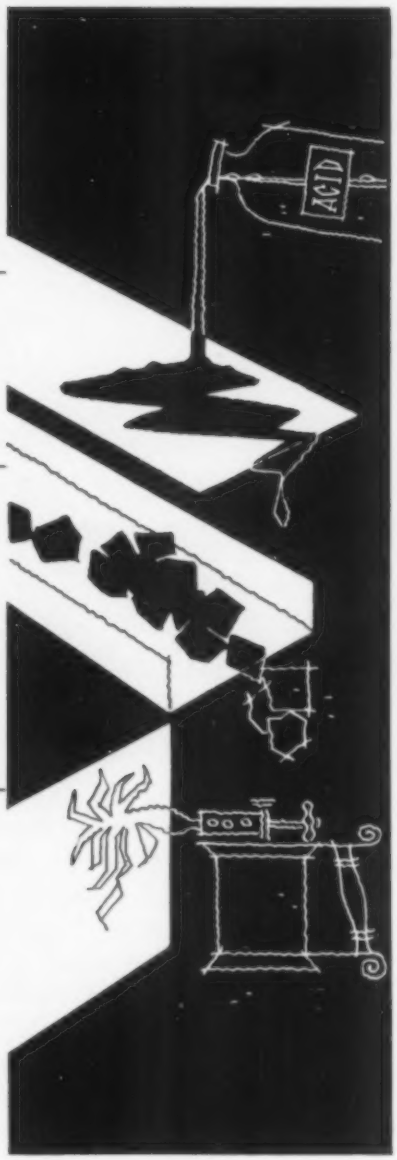
to protect your products

against:

corrosion

abrasion

high temperatures



No other finish can give the protection afforded by Porcelain Enamel! This completely inorganic material, combining the strength of steel with flint-hard glass, is unaffected by conditions that would wear-out, rust-out or burn-up other materials. By using Porcelain Enamel in critical applications, designers improve the performance of their products, and at the same time frequently reduce weights and lower costs.

And where beauty and color are desired to increase the attractive appearance and sales appeal of a product, Porcelain Enamel fills every requirement. It is unsurpassed in range of colors and surfaces, and retains its original beauty and color *for life*!

We will be glad to help you use this modern material to make *your* products more serviceable, more durable, more salable.

Frit Division PORCELAIN ENAMEL

PORCELAIN ENAMEL INSTITUTE, INC.

This message sponsored by the Frit Division of the

PORCELAIN ENAMEL INSTITUTE, INC.

1145 Nineteenth Street, N. W. • Washington 6, D. C.

PORCELAIN ENAMEL INSTITUTE, INC.
1145 Nineteenth Street, N. W., Washington 6, D. C.

Please send me design information about PORCELAIN ENAMEL for possible application to _____
(type of product)

Name _____

Company _____

Address _____

These are the basic elements necessary to design and produce a precision built spring. To supply the above elements takes skill, experience and imagination . . . ingredients that Accurate Spring provides every one of their customers every day.

Accurate makes millions of springs a month—precision springs held to close tolerances by rigid quality control and inspection. Production schedules for large quantities are planned well in advance. Customers are assured of deliveries scheduled to their needs.

Proper packaging is necessary too, for ease of handling and speeded production. Untangling springs can be irksome and expensive.

Accurate has a blueprint for successful spring design and quantity production. When you plan springs, plan with Accurate Spring Mfg. Co.

Accurate Springs

SPRINGS
WIRE FORMS
STAMPINGS

ACCURATE SPRING MFG. CO., 3815 W. Lake St., Chicago 24, Ill.

depression as a cub engineer. Now I am living through the shortage of engineers in a supervisory capacity where I am attempting to keep an efficient staff and constantly battling top management to get them proper compensation.

Frankly, an engineer's progress and standing in the profession is largely dependent upon his ability to do a job and to sell his services to his superiors. It is my opinion that most engineers would be more successful in their careers (and naturally compensation), if they were given a little broader background, particularly in dealing with and handling people. My observation has been that an engineer improves his standing in compensation in almost a direct ratio to his willingness to take part in community and civic affairs. I believe Professional Societies have a very useful function and as a result, have been very active in them, but I am firmly convinced that Professional Societies can actually contribute very little to a man's success as far as compensation is concerned. Unions, as a compensation negotiating medium, have no place in the engineering profession and I believe that I would leave the engineering profession should unionization become widespread.

Motivation is Lacking

TO THE EDITOR

Whereas the responsibility of Management is clear, perhaps ability to motivate the technical man in accordance with his capacity is lacking. Acknowledging that pay should be related to productivity, then the ability to measure productivity is an important factor in establishing fair pay.

A great deal of work has been done in the field of job descriptions and performance reviews. Perhaps these methods lack something in the way of quantitative measures of productivity. The quality of the work also has a positive bearing on the value of the effort. With a better measurement of the engineer's contribution it will be easier to justify higher pay incentives. Since there is apt to be a wide variation in performance of individuals doing engineering work, it may follow that average figures are not a good index of the potential value of an engineering education.

RUBATEX ACCEPTED AS CLARK CONTROLLER'S "UNIVERSAL" GASKET

Gordon R. Fish, Foreman, Cabinet Department, inspects Rubatex on cabinet. Unique closed cellular structure of Rubatex makes non-ventilated enclosures air and watertight as well as weather resistant for wide variety of Clark's electric control apparatus.

Permits complete interchangeability
Saves material and production costs
Meets requirements of NEMA enclosure definitions

Prior to 1950 The Clark Controller Company used natural rubber, felt and neoprene gaskets depending upon the conditions under which the equipment was to be used. After extensive tests, Rubatex Closed Cellular Rubber was found by them to meet every condition and specification required by both their own engineering department and NEMA enclosure specifications.

"In looking for a single gasketing material which would be suitable for use on various types of industrial control enclosures, several types were investigated and tested. Rubatex R-219-N was found to have the desirable characteristics necessary to withstand the conditions under which industrial control is applied."

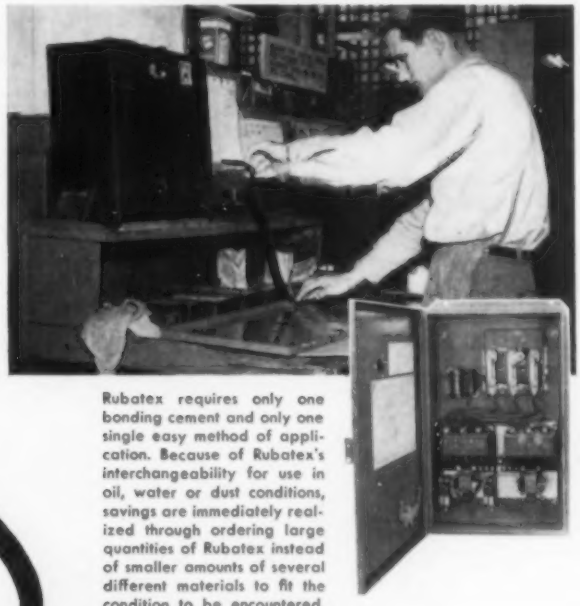
Roland Russo
Manager, General Engineering Standards Department
The Clark Controller Company
Cleveland, Ohio

The particular problem overcome by Rubatex strip stock at Clark Controller is one of efficient sealing against leakage of any sort. For example—if a control is situated in an extremely dusty atmosphere, the dust surrounding the cabinet must be kept out of the control enclosure and away from the electrical arcs and mechanical parts therein.

In other applications the door seal must effectively protect the control against moisture, oil, abrasives and other types of destructive atmosphere.

Rubatex R-219-N Closed Cellular Rubber meets all of these requirements and in addition reduces gasket costs and provides greater manufacturing efficiency.

Why not check to see how Rubatex can do a more efficient job at less cost for you?



Rubatex requires only one bonding cement and only one single easy method of application. Because of Rubatex's interchangeability for use in oil, water or dust conditions, savings are immediately realized through ordering large quantities of Rubatex instead of smaller amounts of several different materials to fit the condition to be encountered.

RUBATEX
CLOSED CELLULAR RUBBER
LEAKPROOF GASKETS

Send for Free Sample and full details

RUBATEX DIVISION, Dept. P-6
GREAT AMERICAN INDUSTRIES, INC.
Bedford, Virginia

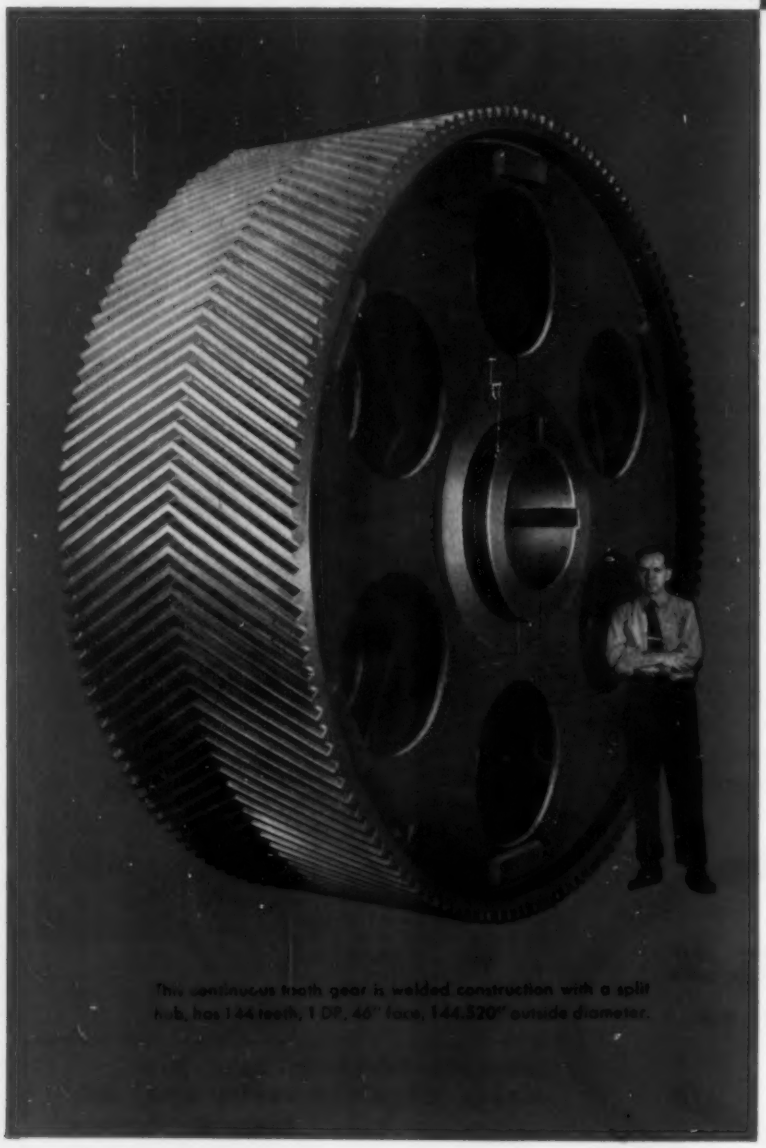
PIONEER MANUFACTURERS OF CLOSED CELLULAR RUBBER

For full details and sample of the new Rubatex Closed Cellular Rubber Leakproof Gaskets—print your name in space below, attach to your company letterhead and mail to us.

Name _____

BACKBONE

comes in any size up to 23' for any power capacity



This continuous tooth gear is welded construction with a split hub, has 144 teeth, 1 DP, 46" face, 144.520" outside diameter.

Farrel continuous-tooth herringbone gears are made in a complete range of sizes from ¼ inch to 23 feet diameter, ¼ to 60 inch face, 24 DP to 0.75 DP, for any power capacity and any application.

The backbone in Farrel herringbone gears, formed by the meeting of the two helices without a center groove, puts the entire face width of the gear to work for you. This pays off in extra strength and greater load and shock capacity—ideal for heavy-duty applications.

Farrel can also supply straight tooth (spur) gears, single helical gears and internal gears in a wide range of sizes—all precision-generated on Farrel-Sykes machines.

Farrel engineers are available for consultation on your gear problems.

•

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.

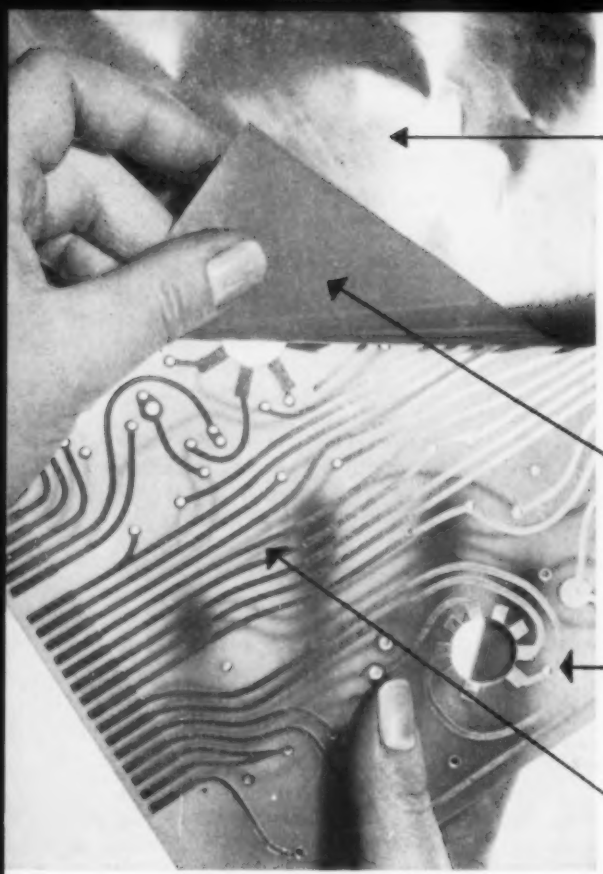
Sales Offices: Ansonia, Buffalo, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston FB-1092

European Office: Piazza della Republica 32, Milano, Italy

Farrel-Birmingham®

ARALDITE® EPOXIES
come through with the answer to...

cyanide-resistant
Copper-To-Plastic adhesives
for
Printed Circuits!



Printed circuits such as this start with a sheet of electrolytically deposited copper of 99.5% purity (generally .00135" or .00270" thick). This is coated on one side with . . .

Plymaster Type "C" a specially formulated Araldite Epoxy-based adhesive which features high resistivity and other electrical insulating characteristics comparable to those of the baseboard. This "PLYMASTER" adhesive-coated copper is then bonded to . . .

An epoxy-impregnated fiberglas baseboard which incorporates excellent electrical characteristics . . .

Excess copper is then etched away, leaving a "printed" electrical circuit on one or both sides of the epoxy "board" . . .

Highest grade circuits for use under extreme service conditions, are then plated on top of the copper with a more oxidation-resistant metal (silver or gold). Although these plating baths contain cyanides, new PLYMASTER TYPE "C", utilizing an adhesive based upon Araldite Epoxy Resins, shows no decrease in bond strength even under severest plating conditions.

The Technical Services of CIBA's Plastics Division are the finest in their field. For full information on how CIBA Araldite Epoxies can help you achieve product development and production improvements such as this, write . . .

Drastically reduced costs . . . lighter weight and compactness . . . higher uniformity in production and consistent reliability in service . . . all the "plus" features that favor printed circuit design for electrical and electronic assemblies come through where the bonding agent is Araldite Epoxy-based Plymaster® Type "C", a development of Rubber and Asbestos Corp.

The efficiency of any printed circuit is only as good as the ability of the adhesive to provide not only necessary bond strength but positive resistance to moisture absorption and with insulating characteristics comparable to the baseboard.

How well this newest Araldite Epoxy-based Adhesive tests out under actual production and service conditions is detailed in the picture-captions at the left.

CIBA

"FIRST IN EPOXIES"

CIBA produces *basic resins only*, to be formulated for intermediate and end uses.

CIBA COMPANY INC., Plastics Division
Kimberton, Pennsylvania

PE-5

Please send me full information on CIBA Epoxy Resins for

- ☐ General
- ☐ Tooling
- ☐ Structural Laminates
- ☐ Surface Coatings
- ☐ Electrical
- ☐ Hi-Strength Adhesives
- ☐ Plastic Body Solders

NAME _____

COMPANY _____ TITLE _____

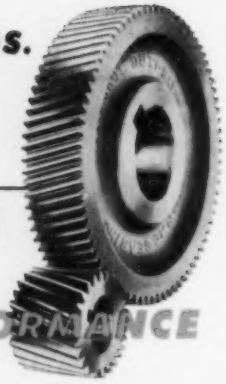
ADDRESS _____

CITY _____ STATE _____

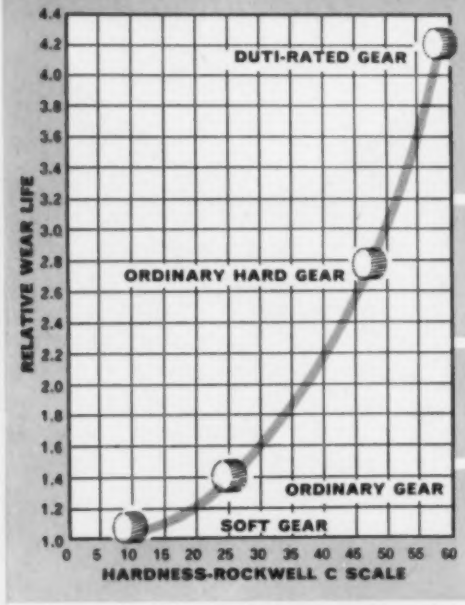
HERE'S WHY FOOTE BROS.

Duti-Rated
LIFETIME GEARING

GIVES BETTER PERFORMANCE
...LONGER LIFE



GEAR PERFORMANCE COMPARISON CHART



DUTI-RATED GEAR—
Hardened after cutting. Precision processing permits maximum hardness while holding accuracy within extremely close tolerances.

ORDINARY HARD GEAR—
Hardened after hobbing and shaving; hardness limited to maintain reasonable accuracy.

ORDINARY GEAR—
Hardened before cutting; hardening limited to maintain machinability.

SOFT GEAR—
Low hardness—excessive size required because of low capacity.

LINE-O-POWER Speed Reducer

AND YOU GET
Duti-Rated
Gearing in EVERY
Line-O-Power Drive

LINE-O-POWER Right Angle Drive

Horizontal GEARMOTOR Speed Reducer

Horizontal VARI-MOUNT Variable Speed Drive

Vertical LINE-O-MOUNT Speed Reducer

Write for DUTI-RATED Gear and LINE-O-POWER Catalogs.
See how you can get more for your drive dollar.

this trademark stands for the finest industrial gearing made

T. M. REG. U. S. PAT. OFF

FOOTE BROS.
Better Power Transmission Through Better Gears
FOOTE BROS. GEAR AND MACHINE CORPORATION
4575 South Western Boulevard Chicago 9, Illinois

OUR READERS SAY . . . . . .

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

How to Be a Product Engineering Author

To the Editor:

The company by which I am employed does not appear to be particularly interested in having employees contribute articles to technical publications. By that I don't mean to imply that they discourage the practice, they merely do nothing to encourage it.

However, I am sure that there must be others, like myself, who would like to tackle an article now and then if we just knew how to go about it. For example, how does one submit an article, and to whom should it go? Are there restrictions on subject matter, length, illustrations, composition?

If you could brush away a few of the clouds that obscure this whole picture for me, I would greatly appreciate it. —JOHN K. BATEMAN
Buffalo, N. Y.

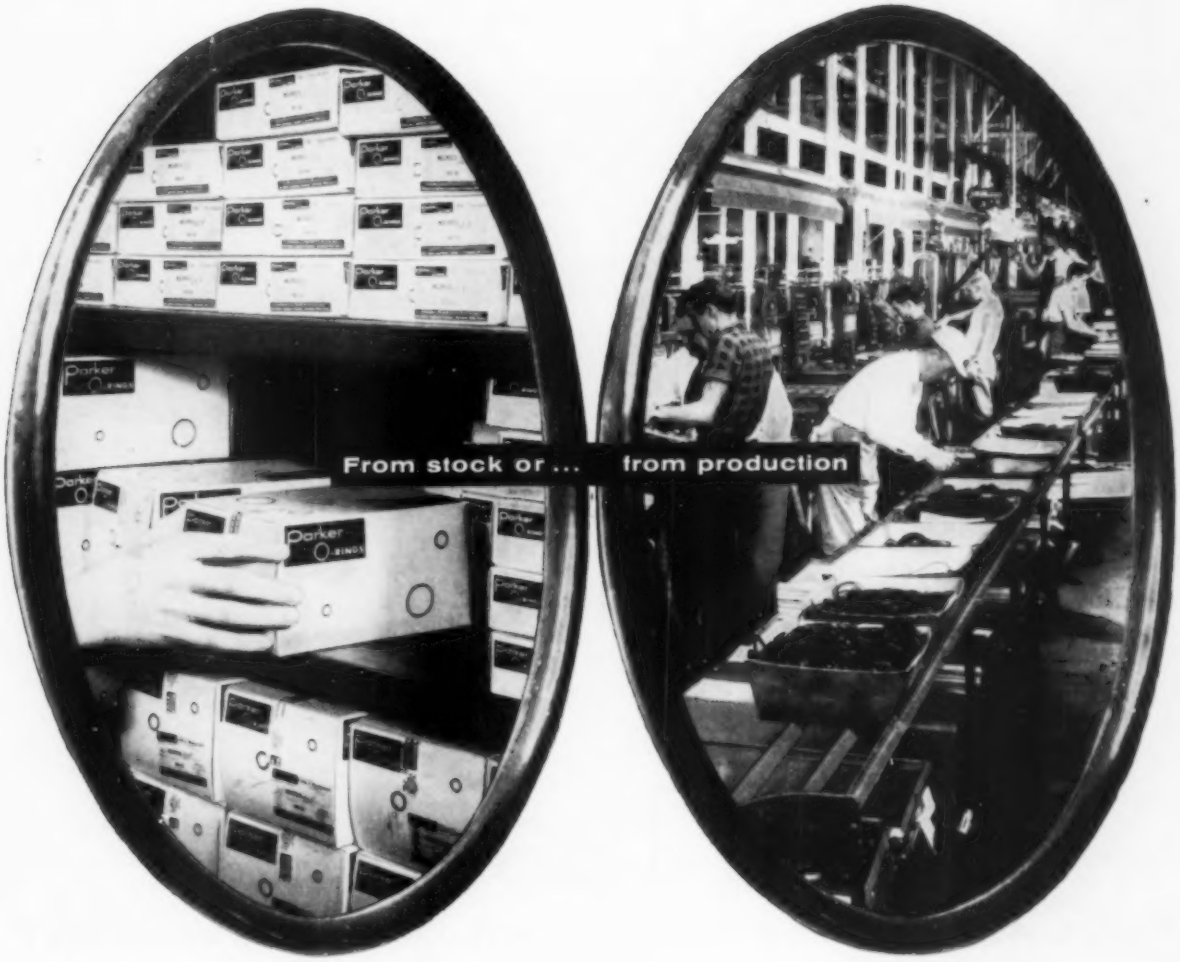
Ed—Unfortunately, a number of companies have the same attitude that your employer has. They do not realize that publicity about their methods and techniques will indirectly result in more prestige for their company than do some of the directly descriptive articles published in magazines read by their customers.

The process of submitting an article is really not at all difficult. The simplest method is to write us first in reasonable detail, giving the subject of the article and outlining how you propose to handle it. Our editors will look over your outline and decide whether or not we are interested. If we are, we can frequently give suggestions for improvements, suitable length, and even the approach that should be used.

We can also suggest illustrations that will be necessary—drawings or photographs. You would then go ahead and expand the outline in ac-

(Continued on page 382)

No matter how many you need...



we offer fast delivery of O-rings!

Parker can meet *any* demand for O-rings. Factory stocks (millions of O-rings) are maintained in Chicago, Cleveland and Los Angeles. Large warehouse stocks are available at more than 50 Parker O-ring distributors. You can get standard sizes of AN, MS, industrial specifications, etc., right off the shelf. (And we have over 296 standard O-ring sizes with many different standard compounds.) Parker also has the production facilities to handle "specials" and volume requirements.

From Parker you get exactly the right O-ring for your specific requirements. Our engineering service will help you with any designing problems. We invite you to prove by comparison tests how Parker O-rings seal better and last longer.

Parker
Hydraulic and fluid system components

RUBBER PRODUCTS DIVISION
Section 522-U
The Parker Appliance Co.
17325 Euclid Ave., Cleveland 12, Ohio

☐ Please send O-ring Size Catalog No. 5701

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

Here at last

FULL 42-INCH PRINTMAKING IN A CONVENIENT

Table Model

Now, TABLE MODEL convenience, LOW COST and FULL WIDTH are combined in *one* whiteprinter—the new Ozalid Streamliner 200!

Now, anyone can turn out sparkling whiteprints in seconds—up to 42 inches in width! In the small office, the new Streamliner 200 gives you prints whenever you need them. For the large firm, it handles "rush work"... saves costly interruptions of volume printmaking... *stands by* when other machines are "down" for service.

Compact in design, Streamliner 200 stands just 22″ high . . . 38″ deep, with feedboard. Prints stack automatically. Controls are simple, easy to operate. Stand, shown above, is optional.

Why not test-run your own tracings through the Streamliner 200? Call your local Ozalid representative or write: Ozalid, Department **O-5,** Johnson City, New York.

A Division of General Aniline & Film Corporation
In Canada: Hughes Owens Company, Ltd., Montreal

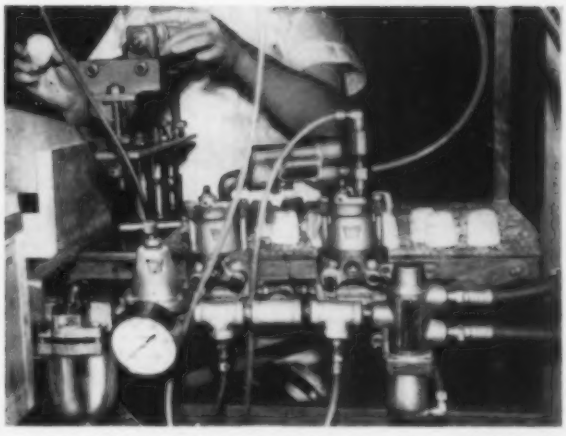
OZALID®

First name in whiteprinting

***Progress** in designing air systems:*

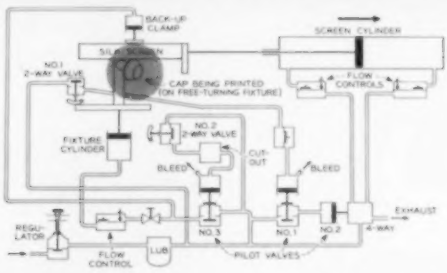
Here's an automating idea: Schrader Air Products in a precision programming operation

PROBLEM: To print bottle caps accurately at high speed.

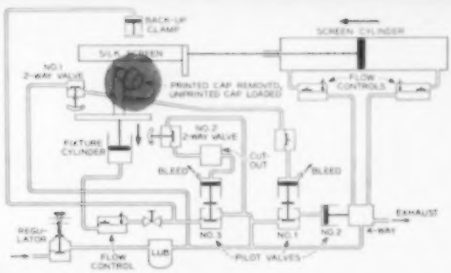


PROVED IN OPERATION: Prominent silk screen printer puts Schrader products to work at a profit.

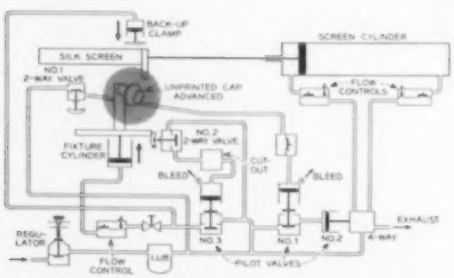
SOLUTION: Adapt Schrader Air Products to silk screen printer.



1 Fixture holding plastic cap on freely rotating fixture is held up against silk screen by Schrader cylinder. Another Schrader cylinder pushes screen sideways over the freely rotating cap, imparting the printed message.



2 Fixture with printed cap moves down, back-up clamp retracts and screen cylinder returns to initial position. Operator removes printed cap and loads another unimprinted cap.



3 Schrader cylinder advances fixture upward loaded with unimprinted plastic cap. Back-up clamp starts downward toward silk screen. And cycle starts all over again.

This is but one precision operation of the limitless operations which can be controlled *fast, economically* and *accurately* by Schrader Air Products. The hundreds of different units in Schrader's complete line can be employed alone or in combination to perform stamping, programming, forming, measuring, squeezing—other jobs too! And wherever air is used, economy is basic.

Test the performance of all your machines against the efficiency that could be achieved with air. Schrader engineering facilities are available to help you. Outline your problem to us and assistance will be prompt. Right now, mail the coupon.

Schrader®
a division of SCOVILL
QUALITY AIR PRODUCTS

A. SCHRADER'S SON · Division of Scovill Mfg. Co., Inc.
477 Vanderbilt Avenue, Brooklyn 38, N. Y.
Please send latest informative booklets which show Schrader's complete line of Air Control Products.

Name_____ Title_____

Company_____

Address_____

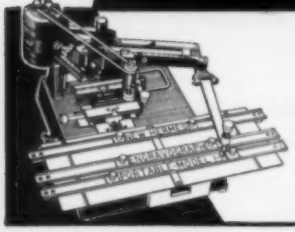
...assure positive lubrication

Howe Ice Machine Company of Chicago, Illinois, uses built-in Viking Pumps to assure positive lubrication of compressor bearings, pistons and cylinder walls. Their system incorporates a Viking 3½ gpm rotor, head and idler into an integral casing. They are rugged pumps, serving dependably 10 to 20 years. Used by Howe since 1921, Vikings have proved so satisfactory that other manufacturers have since used similar pumping systems. If you are using or planning equipment that could use built-in pumping, investigate Vikings. To start, write for bulletin 57Sx.

VIKING PUMP COMPANY
Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" pumps
THE ORIGINAL "GEAR-WITHIN-A-GEAR" ROTARY PUMP

NAMES AND NUMBERS
on equipment, parts, panels, etc.
STAND *UP* BETTER - STAND *OUT* BETTER
NEW FLEXIBLE, CHIP-PROOF
GRAVO Flex
ENGRAVING STOCK

Shear it, bend it, form it, punch it. Laminated in contrast colors for clear visibility. No filling. High resistance to impact, scratching, flame, moisture, solvents. Costs less, lasts longer. *Send for free sample.*



Do all your marking fast, on-the-spot, with unskilled labor. Use portable, tracer-guided ENGRAVOGRAPH. Over 17,000 in use.

Send for booklet PG-1

new hermes ENGRAVING MACHINE CORP.
13-19 UNIVERSITY PLACE, NEW YORK 3, N. Y.

cordance with the program agreed upon between you and the particular editor and submit the manuscript when complete. Your original outline and proposed article should be addressed to the editor, but your later correspondence will be directly with the associate or assistant editor who will be handling the manuscript through to completion.

To a considerable extent, we allow subject matter to control length and illustrative elements. There is no real formula for proper article length beyond the one used some years ago to control the length of women's skirts, namely, long enough to cover the subject and short enough to be interesting. Each magazine has its own definition of its field. In fact, one magazine in the field may accept an article on a subject that another would not. If you submit an article to us that we consider out of our field, or too similar to a recently published article, we can often suggest a second potential purchaser.

Generally speaking, all technical magazines are primarily interested in the idea and the exposition. The exact form and language are not too important. It is helpful to the editor, of course, if the author expresses his ideas clearly, but correct use of grammar and punctuation and correct spelling are not vital. That's the sort of thing we are paid to do and are supposed to be experts at doing.

We also make our own finished drawings, so we can work from fairly rough sketches. Of course all editors dream of receiving manuscripts typed in double or triple space, with illustrations ready to go to the engraver, but this very seldom happens.

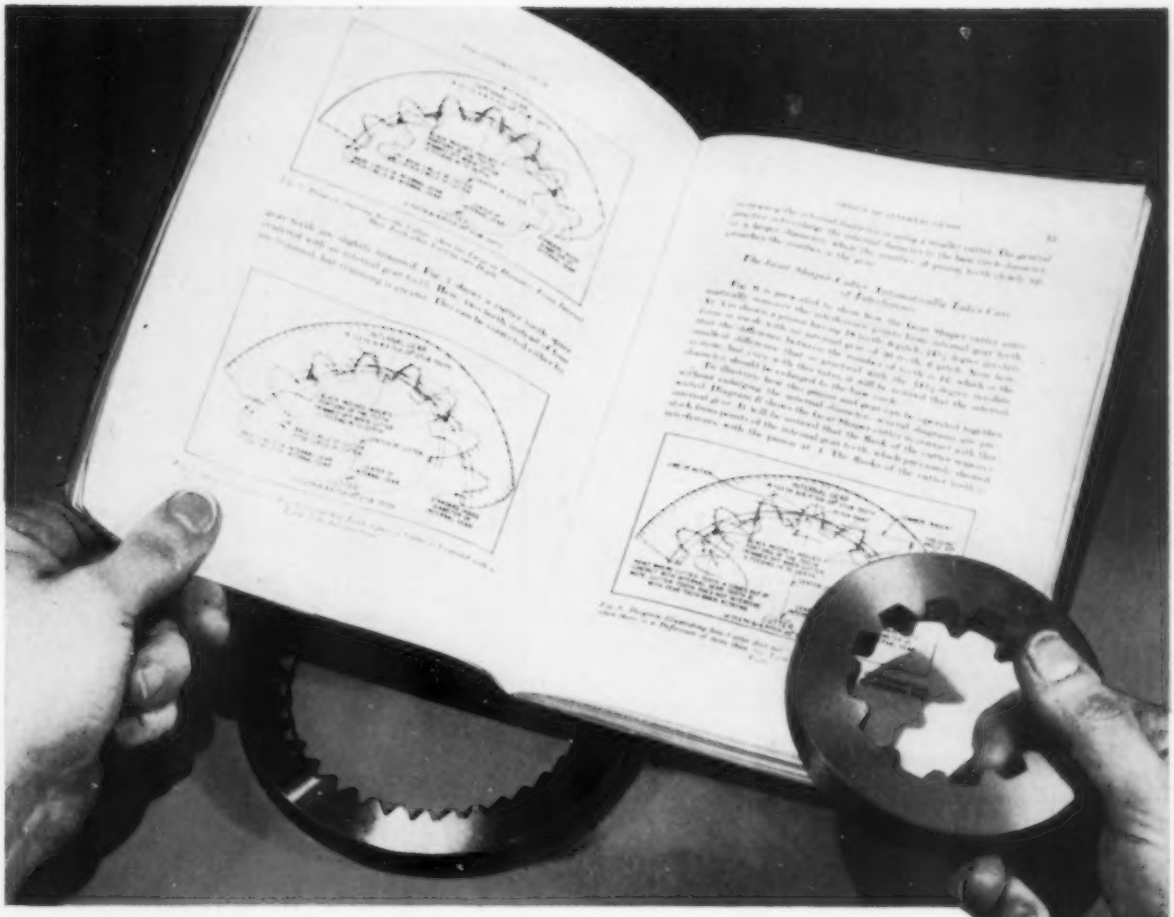
Octagonal Slide Rule

To the Editor:

In *Product Engineering* for March 1957 I read under "Interesting To Note" about the slide rule that lost its origin. This was an octagonal slide in a bamboo box purchased in the Far East during the 19th century and given to Keuffel and Esser Co.

A former employee of mine from New Bedford, Mass., found an octagonal slide among his father's possessions, which appears to be the same as the slide shown in the photograph

(Continued on page 386)



What every designer should know about
INTERNAL GEARS and GEARING

The internal gear, although it has certain limitations, has a number of advantages over the external gear, especially from the standpoint of compactness of design and more efficient tooth action. Most of the so-called limitations can be readily overcome by a proper understanding of the conditions to be met.

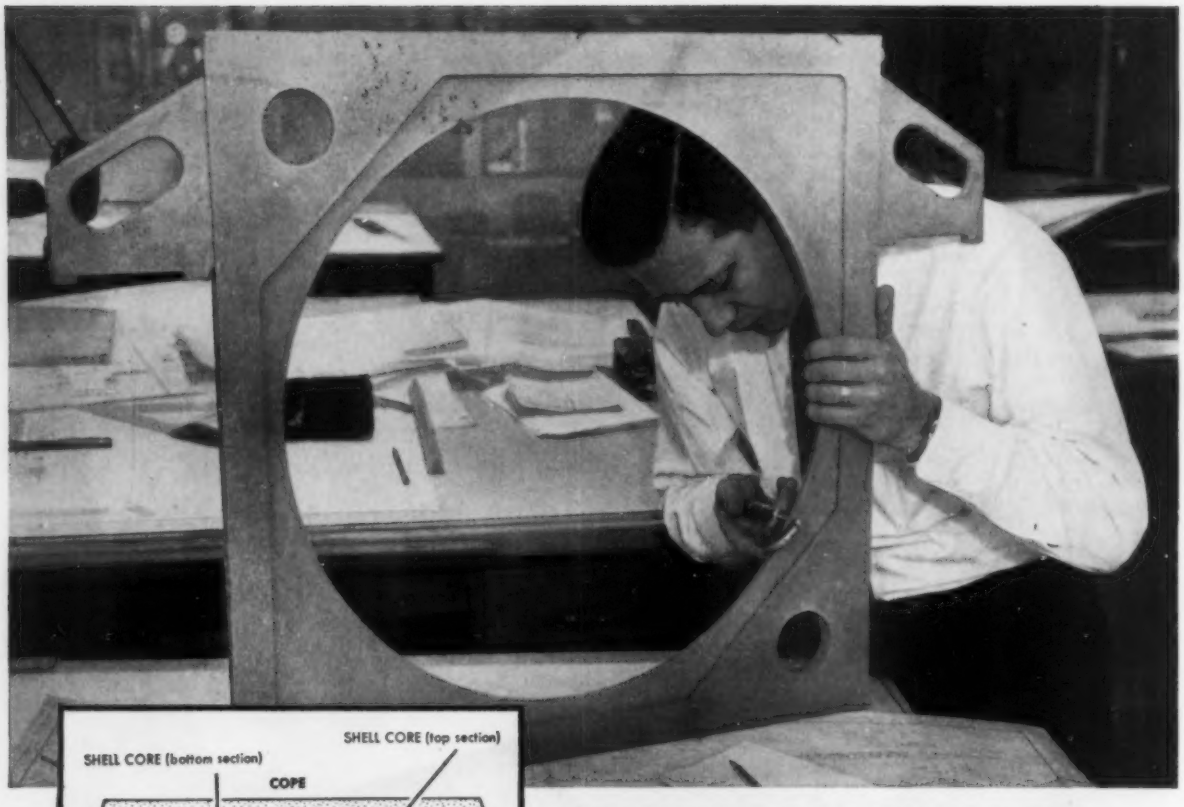
These advantages and limitations are explained in "The Internal Gear", a complete treatise on Internal Gear Design. This booklet contains information on the design and cutting of internal gears, clutches and splines, the analysis of gear tooth action and the calculation of gear tooth strength. Just write to any Fellows office for your copy.

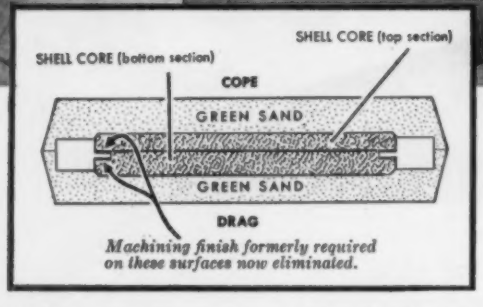
Internal gears, as well as an almost unlimited variety of other internal contours, can be produced at low cost on Fellows Gear Shapers. In many cases the same Gear Shaper cutter can be used to cut both the internal gear and its mating pinion. Production is as simple as the production of external gears.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont

Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE **Fellows** *Gear Production Equipment*





CAST TOLERANCE OF ±.015" HELD in stainless steel filter plate web

Costly milling operation now eliminated by Cooper Alloy precise-dimension casting. Here's how it cut Tennessee Eastman's costs . . .

PROBLEM: To cast these filter plates in one piece (26" x 26" sq.) with the thickness of the center web held to .310" ± .015". Deviations from this tolerance would result in improper seating of filter cloths. Normal sand casting methods could not produce the required accuracy.

SOLUTION: To secure the precise dimensions required for the inner "web", Cooper Alloy placed a special shell core *inside a greensand mold*. When closed, space between the shells provides precisely uniform thickness, and surface of shell assures a superior finish.

Today, thanks to Cooper Alloy "Advanced Casting Know-How", this piece, using one of the largest shell cores ever made, is being successfully produced in quantity by Cooper Alloy. It saves Tennessee Eastman hours of machining time and thousands of dollars in finished-piece costs.

Cooper Alloy, a specialist in stainless steel for 35 years, is still a pioneer in the development and application of new techniques for handling this tricky metal. Next time *you* have a tough problem, and there's a chance that a unique casting method can save time and money, talk to Cooper Alloy.

COOPER ALLOY

Corporation • Hillside, New Jersey

FOUNDRY PRODUCTS DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

"Inside-out" bushing
This drawn strip type bushing is lined on the outside diameter with Federaloy HF-16 leaded bronze.
The I.D. and the flange are both bearing surfaces on this formed bushing
Drawn and flanged strip type bushing, lined on the I.D. and the thrust face with Federaloy HF-16 leaded bronze.
The bushing with the bearing surface where you want it
I.D. or O.D. or both of this formed steel bushing can be lined with our sintered copper-alloy.

Where cost reduction is a factor . . . consider bushings with bearing performance

Our formed bushings and thrust washers are widely used for automatic transmission and other applications. They can be solid bronze or steel lined on either or both surfaces. Washers can be "lined" on both faces. Many special features can be incorporated—grooves, holes, nibs, ball indenting; straight, special or locking seams. We provide complete engineering service. Address:

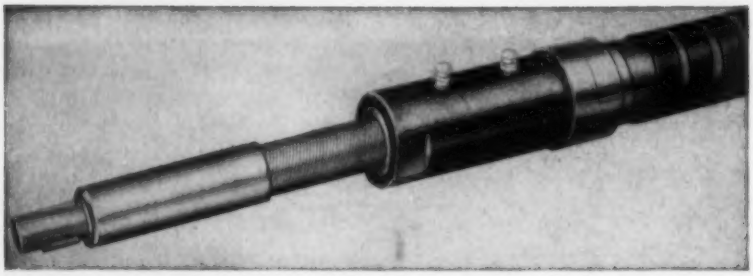
FEDERAL Mogul SINCE 1899

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

HOW TO SELECT
FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. **Torque (Lb. In.)** to be transmitted. (The starting torque should be used in making selections.)

2. **Operating Speeds (RPM)**—If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. **Operating Radius**—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

RATINGS—The ratings for flexible shafts shown in the table below apply under the following conditions:

1. when the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. when the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.)

3. when the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

If you have a specific design problem you wish to discuss, you can consult with our Chief Engineer, Mr. G. G. Eisenbeis, and other Stow flexible shaft engineers at our Booth #302 at the coming Design Engineering Show, May 20-23 at the New York Coliseum.

For Engineering Bulletin No. 570 and a free torque calculator, write

STOW

STOW MANUFACTURING COMPANY

426 State Street, Binghamton, New York

in your magazine. As it came from New Bedford (whence ships went to the Far East during the 19th century) it may be made by the same man who made the slide rule you speak of.

—Peter Kilham
N. Attleboro, Mass.

Ed—We were most interested to learn of the existence of a second octagonal slide rule. Several members of our staff tried vainly to operate K & E's instrument. It is still a mystery to us.

Filing for Reference

To the Editor:

I want to be concise, yet exhaustive.

Sincerest compliments to you for your excellent publication. I saved quite a number of copies for reference until they began crowding me. Also, to locate something specific was difficult and cumbersome.

So I started a tear-sheet library so that I could have information on one subject in one package. Then a big trouble developed: last page of one article is often the first page of the next one. This means that I had to sacrifice one, which was very discouraging!

My humble suggestion is for articles to be arranged without interfering with each other. Ads might be used as fillers, particularly if ads of products of the same nature as the article theme could be used.

This should make the magazine in itself even more attractive than it already is to both buyer and promoter. However, maybe the present technique is applied on purpose: to discourage tearing up the magazine. If not, a few changes could render the engineering profession an inestimable service.

—Ernest A. Kremeyer
St. Joseph, Mich.

Ed—We know we have the problem you describe. It is a complex one as you intimate and involves some fine points of publishing policy as well.

I cannot give you the answer to your letter, but I can tell you that we are thoroughly aware of this tear-sheet problem. I hope we will have some kind of an answer before too long. Meanwhile, our best reply is the one you pointed out—to file carefully uncut copies for as long as you have space. Perhaps you have noted our

(Continued on page 390)

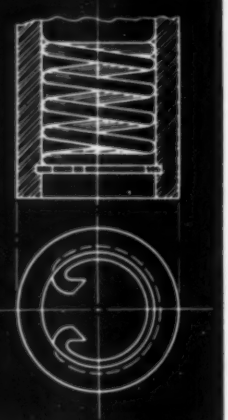
MEMO TO ENGINEERS—

Simplify your designs with—

NATIONAL RETAINING RINGS

Request Catalogs Today—

or ask a NATIONAL Sales Engineer to give you the facts on your particular design application at your convenience.



...eliminate costly shoulders

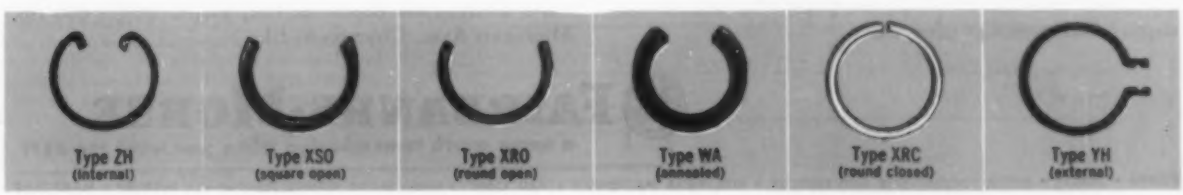
...groove smaller shafts and housings

Installing NATIONAL Retaining Rings in simple grooves permits the use of smaller shafts and housings . . . saves machining and material wasted when larger shafts are cut down to make shoulders. Thousands of performance-proven applications include heavy machinery, engines, drill presses, tools, toys . . . products of metal, plastics and wood. Simplify the design of your products by utilizing the high efficiency of these easily installed NATIONAL Retaining Rings. Save weight, space, material, production and assembly time!

THE NATIONAL LOCK WASHER COMPANY

Serving Industry Since 1886

NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN



Fairbanks-Morse fire pumps provide 12,000 gpm. of water at 100 psi. for each of two systems.

World's largest jet aircraft center protected by F-M fire pumps

Four major aircraft companies—Lockheed, North American, Convair and Northrop—use the 5000-acre U. S. Air Force Plant No. 52 at Palmdale, Calif., for assembly and testing.

Maximum protection against fire at this gigantic operation was achieved at minimum cost by installing two identical, interlocking water supply systems, each equipped with Fairbanks-Morse pumps for both water supply and sprinkler pressure.

The size and scope of this installation indicate Fairbanks-Morse's ability to supply fire pumps for all magnitudes of industrial and municipal requirements. Whatever your needs in fire protection—big installations or small—your Fairbanks-Morse Field Engineer will be glad to work with your own engineers, in specifying the most efficient equipment. Call him today, or write Fairbanks, Morse & Co., Dept. P-5, 600 So. Michigan Ave., Chicago 5, Ill.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

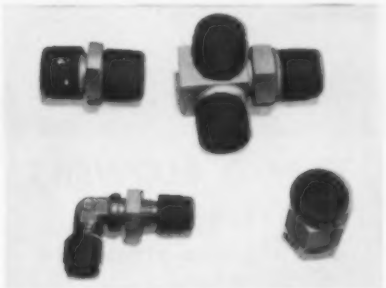
PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MOWERS • MAGNETOS

a free **CaPlug** assortment like this

will give you dozens of ideas for protecting products like these

JUST PUSH THEM IN . . . OR PUSH THEM ON
Tapered (non-threaded) CaPlugs can be used as caps or plugs, inside or outside of threaded or plain fittings. Threaded styles are knurled to screw on or off with ease. Made of tough, flexible Polyethylene, CaPlugs are unaffected by most chemicals, acids and solvents . . . will not collapse, chip, break or shred.

"KID GLOVE" PROTECTION WITH A DUAL PURPOSE
Here's how Resistoflex Corp. makes two-fold use of CaPlugs "to protect critical threads and machined surfaces and to keep the interiors of hose assemblies clean and dust-free." Says Resistoflex, "CaPlugs prove most effective for both functions as well as being particularly easy to install."



COUNTLESS USES BY THOUSANDS OF USERS
Bell Aircraft Corp. applies both threaded and non-threaded CaPlugs to a wide variety of parts (such as these) in the manufacture of guided missiles, electronic components, rocket engines and servomechanisms. Throughout industry, many a company has found that CaPlugs provide the perfect answer to practically every closure need.

MAKES A PRODUCT LOOK ITS "SUNDAY BEST"
On this Alemite Accumatic Valve, colorful red CaPlugs add snappy eye appeal and indicate care of manufacture. Says Stewart-Warner Corp., "CaPlugs help impress the customer with the steps that have been taken to protect the equipment and convince him of the continuing need for protecting lubricants against contamination."

THERE'S A CAPLUG THAT WILL DO THE TRICK *You name it! With numerous styles (threaded and non-threaded) stocked in over 500 sizes, "off-the-shelf" deliveries can be made from a 35,000,000 inventory to answer your immediate requirements promptly. You get closures that are right for your jobs . . . right on time.*

GET A FREE BOX OF CAPLUGS, DETAILS AND PRICES BY MAILING THIS COUPON

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2207 Elmwood Ave., Buffalo 23, N. Y.

RUSH a free assortment of CaPlugs, literature and prices to us, without obligation.

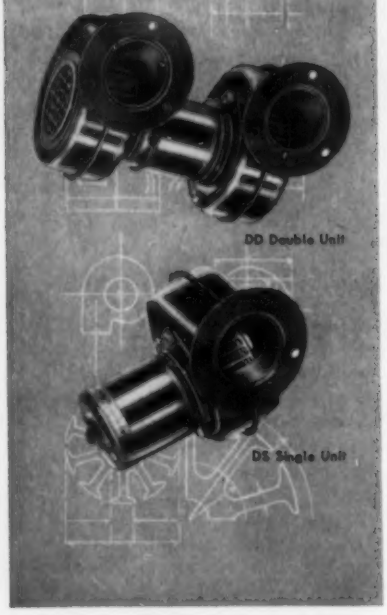
NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

PUT HEINZE IN YOUR DESIGNS



TYPE D BLOWERS

long life
simple maintenance

Single or double blowers, with durable metal housing, are powered by type D shaded pole induction motor. Rugged units require little oiling, won't interfere with radio or TV. Standard operation is on 115 V, 60 cycles, AC. Single unit has load speed of 3200 rpm, 55 cfm; double unit operates at 3100 rpm, 100 cfm. Other frequencies and voltages available.

Heinze Blowers are designed to your exact specifications — for vending machines, photo dark rooms, laboratories, kitchens, refrigerators, air conditioning units, furnace draft boosters, animated displays, cooling electronic equipment, and other general cooling applications. Write for new catalog to Department F

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.

SUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

"Editor's Notes" at the end of a good many of our feature articles, in which we call attention to earlier articles published on the same topic.

An Air Motor Maker Comments

To the Editor:

The method outlined by Otmar E. Teichman in his article, "Analysis and Design of Air Motors", in the February issue differs considerably from those used by some of the air motor manufacturers. However, the basic principles involved are identical. The reduction to non-dimensional relationships is a valuable suggestion for motor comparison.

Several points should be clarified concerning any such analysis:

1) Practically all air motors are mounted in an enclosure which contains exhaust passages to atmosphere. The back pressure in these passages must be considered in the motor design

2) The shape and size of the inlet and exhaust ports in the motor are fully as important as their angular location

3) The true value of exponent n is seldom as low as 1.3 in air motors. We have encountered values as high as 1.39

4) One of the reasons why larger expansion ratios are not used more frequently in air motors is that when the intake cut-off is close to tangency there is insufficient space between the rotor and cylinder to afford adequate inlet port capacity at this point.

5) In most air motors the effect of centrifugal force is more important than the viscous film effect. The reason for this is that the vane, or blade as it is commonly called, always makes line contact with the interior of the cylinder, thus providing very small bearing surface.

6) Air supply at 70 F is much more common than air supply at 100 F. Supply pressures of 80 to 90 psi are most frequent, but restrictions such as small nipples, undersize couplings and hole menders all too often rob the motor of adequate pressure.

7) This analysis assumes that the vanes maintain sealing contact with the inside of the cylinder. The designer always strives to achieve this result. The pressure difference acting

(Continued on page 394)

NEW from MEYERCORD

NAMEPLATE DECALS

If you have adhesive problems with the water applied decals you are now using...switch to NEW MEYERCORD TYPE I

This is BIG NEWS about a new addition to the Meyercord "family" of commercial nameplate decals! Meyercord has perfected a completely new water applied decal nameplate with revolutionary advantages.

This new TYPE I Decal instantly grips virtually any commercial surface with bulldog tenacity. It will cling and adhere with ease to acrylics, metal (painted or unpainted), melamines, polyethylenes . . . to mention only a few of the more difficult.

TYPE I Decals are applied with all the usual ease of any water applied decal but they do not depend upon water solubility for adhesion. Even if oversoaked for long periods there is no damage or adverse effect on the adhesion. TYPE I Decal Nameplates can be designed to include colorful halftones as well as plain poster-style designs. However, for the present, this new TYPE I Decal can be manufactured in production line quantities only.

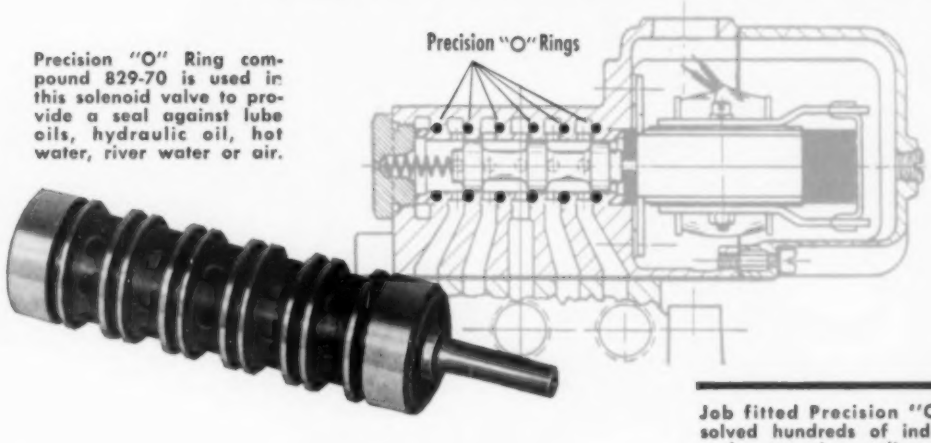
Let us prove that TYPE I can be the answer to the most stubborn nameplate problem. Send sample of surface and material—for samples and full information. Request on company letterhead. No obligation.

THE MEYERCORD CO.
World's Largest Decalcomania Manufacturers
Dept. G-318, 5323 W. Lake St., Chicago 44, Illinois

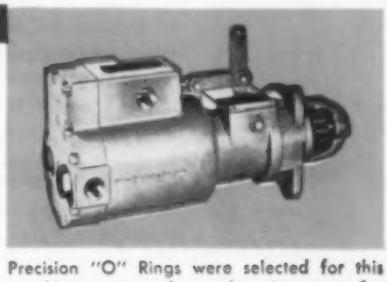
COMPOUND 829-70

Versatile PRECISION "O" RING fills sealing requirement in dozens of industrial products

Precision "O" Ring compound 829-70 is used in this solenoid valve to provide a seal against lube oils, hydraulic oil, hot water, river water or air.



Job fitted Precision "O" Rings have solved hundreds of industrial, aircraft and automotive sealing problems.

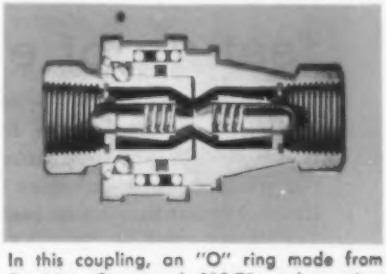


Precision "O" Rings were selected for this cranking motor after exhaustive tests for flexibility and sealing in arctic cold.

Uniformity of size, excellent surface quality, compatability with a wide range of fluids . . . Numatics, Inc. of Milford, Michigan, cite these as reasons why "O" rings made from Precision Compound 829-70 are being used in their solenoid valves. They are giving service through more than 30,000,000 valving actions.

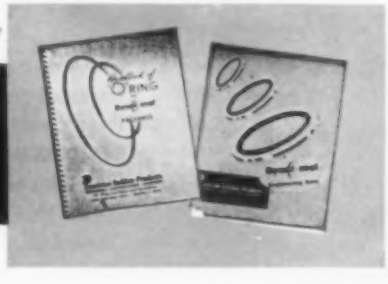
Hundreds of Precision "O" Ring compounds are meeting the exacting requirements of industry. Modern pre-testing methods and engineering skill assure dependable, long life service. They are compression molded — rigidly inspected — meet all military and commercial specifications — the finest made! At Precision, you'll find "O" rings in sizes and compounds to meet your requirements.

What is your sealing problem? There is an expert — the Precision engineer — ready to help you in product design and "O" ring specifications. You can rely on him — and on Precision, the world's largest exclusive producer of "O" Rings.



In this coupling, an "O" ring made from Precision Compound 829-70 seals against hydraulic fluids and pneumatics.

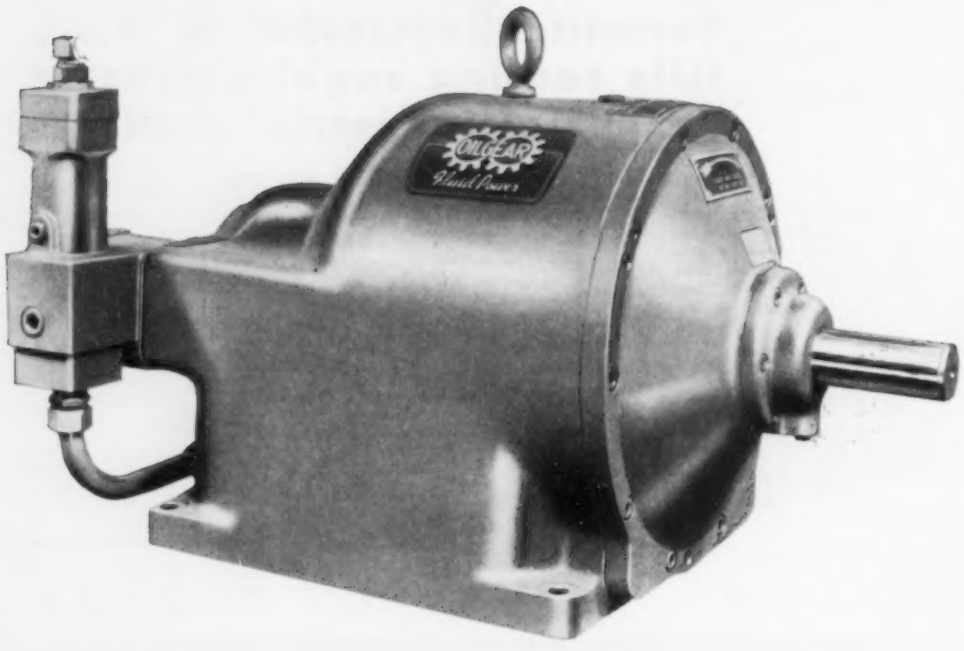
Write for your free copies of Precision catalogs on "O" Rings and Dyna-Seals



Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

Dept. 3, Oakridge Drive, Dayton 7, Ohio

Canadian Plant at: Ste. Thérèse de Blainville, Québec



OILGEAR CONSTANT AND VARIABLE DELIVERY PUMPS. Sturdy, compact units built in sizes having normal ratings from 4 to 150 hp. For over 5 years, Cellulubes kept the durability of these pumps high, even on constant pressure applications.

Where a fire-resistant lubricant is a must—

Celanese Cellulubes give you the plus feature of excellent lubrication . . .

More and more equipment manufacturers and lubrication engineers are learning that fire-resistant Cellulube lubricants provide superior protection against excessive wear during continuous operation under extreme pressures. Tests conducted by The Oilgear Company of Milwaukee, Wisconsin on various fire-resistant fluids showed that Cellulubes "seem to be the most satisfactory fluids for use in Oilgear pumping equipment."

Cellulubes are straight phosphate ester base synthetic oils . . . chemical compounds that contain no additives. Because of this, and because of lower flammability and reduced tendency to form undesirable deposits, Cellulubes can provide excellent lubrication combined with dependable fire protection.

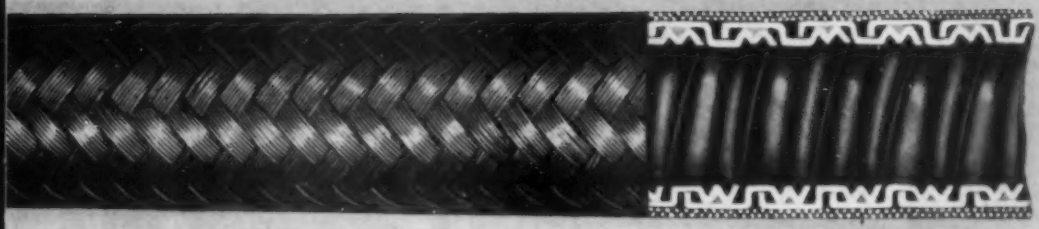
Cellulubes are available for supply in 6 controlled viscosities to meet exacting requirements in the replacement of flammable lubricants presently in use in your plant or equipment. Write for working samples and complete data for a thorough evaluation.

Celanese Corporation of America, Chemical Division, Dept. 547-E, 180 Madison Avenue, New York 16, N. Y.

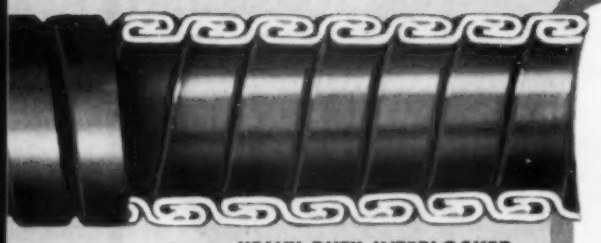
Celanese® Cellulube®

Celanese CHEMICALS

In Canada: Canadian Chemical Co., Limited, 2035 Guy Street, Montreal, P. Q., Canada
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y.



TYPE FP WIRE BRAIDED



HEAVY DUTY INTERLOCKED

LIGHTWEIGHT SQUARELOCKED
Unpacked, cord packed, light asbestos packed, heavy asbestos packed

TWIN-LOK
Galvanized Lined
Stainless Steel Lined

FLEXIBILITY

DEFIES HEAT...FATIGUE ABRASION...LEAKAGE

Penflex is ruggedly built hose with all of the flexibility required, plus the toughness and durability of metal. No matter how hot the material to be conveyed Penflex cannot be cooked like ordinary hose. It stubbornly defies rough abuse, abrasion and crushing.

From 1/8" I.D. to 24" I.D. . . . bronze, galvanized steel, or stainless steel . . . from an air compressor line to a diesel exhaust, Penflex makes them all for industry. And Penflex "Flexineering"—the science of applying flexible tubing to fit the particular needs of the job to be done—assures the right tube in each installation. When you require tubing or hose that is tight as a pipe, but flexible . . . safe at high temperatures . . . and free from metal fatigue, specify Penflex.

Penflex manufactures a complete line of four wall interlocked and seamless welded corrugated flexible tubing for industry. Write for your free copy of the booklet "Flexineering At Work."

Pennsylvania Flexible Metallic Tubing Company, Inc., 7239 Powers Lane, Phila. 42, Pa. *Branch Sales Offices:* Boston • New York • Chicago • Houston • Cleveland Los Angeles and Distributors in Principal Cities

HEART OF INDUSTRYS LIFELINES

PENFLEX

METALLIC TUBING

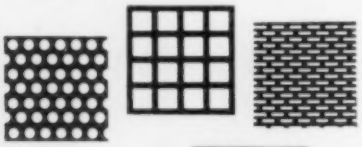
Idea!

room air conditioning unit using H & K perforated metals

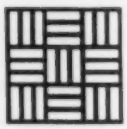
In the ¾ ton window air conditioner illustrated, perforated metals have been combined successfully with injection moulded plastics. The utilization, here, of new louvered perforated metals in adjustable frames on the frounced surface in combination with new embossed patterns on sides and under surfaces, afford rich tactile qualities hitherto unattainable in the air conditioner field.

Harrington & King perforated metals provide the Industrial Designer and other men of ideas unlimited opportunities to offer both functional and aesthetic properties as demanded in products for today's market. Contact H & K for your perforating requirements.

*Product Development by William M. Schmidt Associates



A few of the thousands of H & K perforated patterns. Illustrations are reduced in size.



Fill in and mail coupon to nearest H & K office.

THE Harrington & King PERFORATING CO. INC.

Chicago Office and Warehouse
5617 Fillmore Street
Chicago 44, Ill.

New York Office and Warehouse
104 Liberty Street
New York 6, N.Y.

Please send me—

☐ GENERAL CATALOG NO. 52

☐ STOCK LIST of Perforated Steel Sheets

NAME_____

TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE_____ STATE_____

on each vane tends to bind it frictionally in its slot, thus making continuous sealing contact very difficult to attain.

Let us hope that the readers of this article have acquired a clearer understanding of air motors so that they can select and use them more effectively.

—PAUL VAN SITTERT
Cleveland, Ohio

Ed–You are evidently well aware of the complications that tend to confuse any rigorous mathematical analysis in so difficult a field.

Agrees with Mr. Meyers..

To the Editor:

Perhaps the article on drafting, by R. E. Meyers, will end all discussion on drafting procedure. Whether you call it standardized, simplified or functional becames somewhat unimportant if you fully consider some of the points in Mr. Meyer's article.

Quoting the most important ones in the order of the article but not necessarily in order of importance:

1) "No pencil work should be required in the shop in order to use the drawings."

2) "———minimum views required for complete clarity."

3) "———scale (as long as the proportion is about right)."

4) "Freehand drafting does not comprise clarity and, of course, does not excuse sub-standard or sloppy work."

5) "———whatever views are shown should be complete, with all necessary holes and lines giving an undistorted picture of the part. The danger of oversimplification and consequent misunderstanding cannot be overemphasized."

6) "Also it has been found that thorough training in classical methods is an aid to functional drafting."

Beyond these elements it becomes a matter of company pride as to what further effort should be put into drawings. Anything less is false economy.

I am in favor of whatever it takes to stimulate companies to establish and maintain complete engineering records—namely, understandable detail and assembly drawings, consistent nomenclature, rigid drawing change procedure, and adequate numbering.

—L. E. O'NEIL
Dayton, Ohio

Servospeed
HEART OF AUTOMATION
MODERN ELECTRONIC ENGINEERING GIVES PRECISE MOTOR SPEED CONTROL
Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.
Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

Spaulding

products

FOR ALL INDUSTRIES

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin Fibre Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Thermosetting Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: A Thin, All-Rag Paper Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.

MATERIALS HANDLING PRODUCTS:
Factory Trucks, Boxes, Barrels, Trays, etc.

SPAULDING BRANCH SALES OFFICES

ATLANTA 7, GA.
1250 South Oxford Rd., N.E.
BALTIMORE 18, MD.
2104 North Charles St.
BERKELEY 10, CALIF.
2221 Fourth Street
BOSTON 16, MASS.
585 Boylston Street
Boston Area:
WELLESLEY HILLS 82, MASS.
44 Washington Street
BRIDGEPORT 6, CONN.
2626 Main Street
CAMDEN 1, N. J.
227 South Sixth Street
CHICAGO 34, ILL.
7644 West Belmont Avenue
CHICAGO 25, ILL.
4770 Lincoln Avenue
CHICAGO 38, ILL.
5604 West 63rd Street
Chicago Area:
BERWYN, ILL.
3247 Grove Avenue
CLEVELAND 20, OHIO
3494 Lee Road
CLEVELAND 16, OHIO
19035 Detroit Rd., Rocky River
DAYTON 2, OHIO
136 So. Ludlow Street
DETROIT 1, MICH.
4612 Woodward Avenue
FORT WAYNE 6, IND.
2301 Fairfield Avenue
LANSING 10, MICH.
2021 South Cedar Street
LONG ISLAND, N. Y.
90-34 Jamaica Avenue
Woodhaven 21
LOS ANGELES 15, CALIF.
1325 San Julian Street
MILWAUKEE 8, WIS.
3329 West Vliet Street
Newark, N. J. Area:
WESTFIELD, N. J.
101 Central Avenue
NEW YORK 55, NEW YORK
384 East 149th Street
ST. LOUIS 5, MO.
7247 Olive Street Road
ST. LOUIS 17, MO.
1500 Big Bend Blvd.
SYRACUSE 3, N. Y.
1206 East Water Street
TONAWANDA, N. Y.
310 Wheeler Street
TORONTO, ONT.
106 Lake Shore Road, E.
Port Credit, Ont.
LONDON, ENGLAND
Spaulding's LTD.
40 Gloucester Way
Clerkenwell, London E.C. 1
PARIS, FRANCE
La Fibre Vulcanisee—Spaulding
27 Rue Vincent Compoint

SPAULDING FIBRE COMPANY, INC., 310 Wheeler Street, Tonawanda, N. Y.

Flexon®

bellows and bellows assemblies

design and application briefs

How Honeywell Uses Bellows for Positive Temperature Control with Their Adatrol* Gas Valve

The V5153 Adatrol* Thermostatic Gas Valve, manufactured by Minneapolis-Honeywell Regulator Company is a 100% shut-off gas cock and a bellows-actuated snap-acting thermostat for gas heating devices.

How it Works

When the pilot flame is normal, the thermo-electric power generated by an appropriate pilot burner-thermocouple combination energizes an

Adatrol* Thermostatic Gas Valve.

electro-magnet in the Pilotstat to hold the Pilotstat valve open. However, should the pilot flame become inadequate for proper ignition of the main burner, the thermo-electric current quickly drops off causing the valve to close and block gas flow to the pilot and main burner.

Flexon Bellows is the Heart of the Control

Automatic temperature control is provided by the snap-acting thermostat section that incorporates a Flexon Bellows Assembly. The temperature sensing element (a bulb) is connected to the internal actuating element (a bellows) by a capillary tube. The bulb-tubing-bellows combination is completely filled with a hydraulic temperature sensitive liquid. Changing temperature in the area surrounding the bulb creates a changing pressure in the bellows, which actuates the valve.

Due to the small percentage of total fill in the bellows and capillary, the control is not appreciably affected by temperatures other than at the bulb location. Because it is a solid fill, instrument calibration is unaffected by altitude changes.

Why Flexon Bellows Are Used

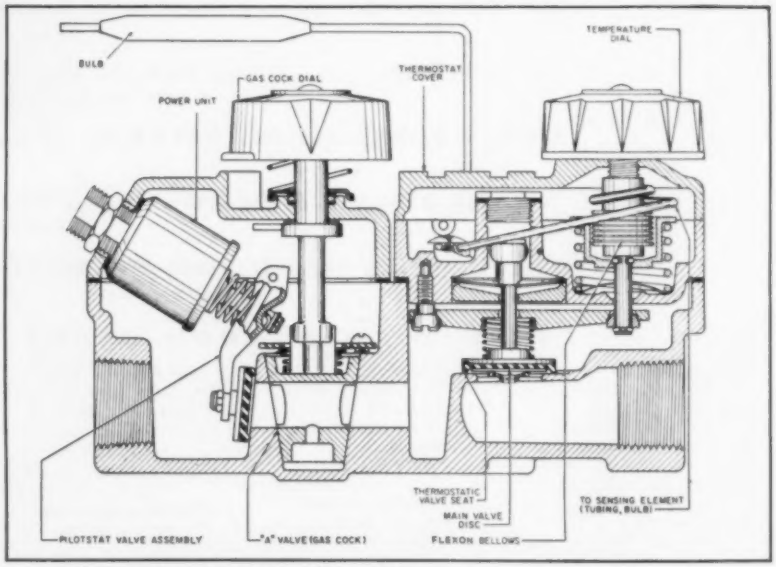
Minneapolis-Honeywell uses Flexon Bellows Assemblies in the Adatrol* Valve to take advantage of Flexonics Corporation's facilities and bellows manufacturing know-how. Flexonics' application engineers are cost conscious, skilled in recommending the bellows or bellows assemblies that provide the performance required by the device at the lowest price consistent with these requirements.

*Adatrol is the trademark of Minneapolis-Honeywell Regulator Co.

View in Flexonics laboratories showing mass spectrometer being used to test bellows for leakage.

Engineering Assistance

The Flexonics Application Engineering Staff will be pleased to assist you in your bellows application problems. For specific recommendations send an outline of your requirements. For your bellows reference file, write for the Flexon Bellows Design Guide.



Cross section of the Adatrol* unit showing the arrangement of elements.

Flexonics Corporation
BELLOWS DIVISION

1351 S. Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

Also Manufacturers of Rubber and Metal Hose Assemblies • Expansion Joints • Aircraft Components

CRACKS THE "HEAT BARRIER" FOR THE CRUSADER!

HARRISON COOLS CHANCE VOUGHT'S SUPERSONIC F8U-1

Sky-high and still streaking up . . . but heat's always down to earth! Chance Vought's *F8U-1 Crusader* depends on Harrison to handle the sizzling engine temperatures encountered in supersonic flight. These heat-exchangers are durable, dependable . . . they're compact, lightweight, and specifically designed to provide the most efficient cooling for America's most advanced aircraft. Aircraft manufacturers can rely on Harrison, with over 46 years' experience in the research and design of heat-control products. If you have a cooling problem, look to Harrison for the answer.

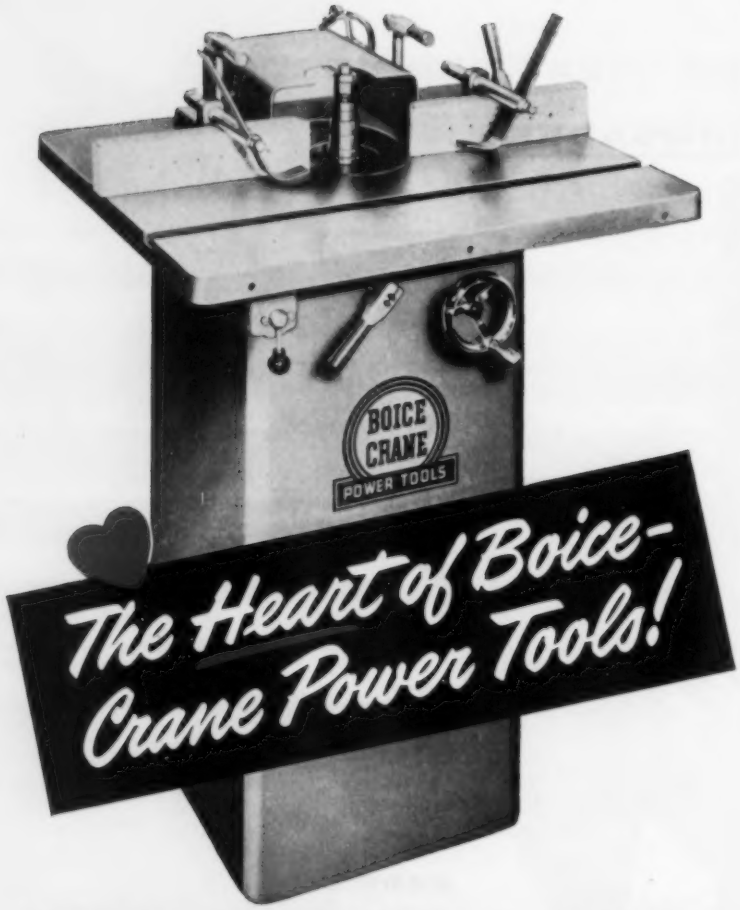
Watch WIDE WIDE WORLD Sundays on NBC-TV

TEMPERATURES MADE TO ORDER

GM GENERAL MOTORS

HARRISON

RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.



BALDOR STREAMCOOLED MOTORS

For years famous Boice-Crane Power Tools have enjoyed a reputation for faultless performance. And for years, like hundreds of other leading manufacturers, Boice-Crane has specified and depended on Baldor Streamcooled Motors to maintain its enviable prestige.

If customers demand this kind of superior performance from *your* equipment, it will pay you to consult Baldor. Experienced engineers are available to help take the kinks out of all your knotty motor problems . . . *without obligation!*

Rear view of Boice-Crane Spindle Shaper showing vertical installation of Baldor Streamcooled Motor.

Write for Catalogs on Complete Line!

Baldor ELECTRIC CO.

4353 Duncan Ave. St. Louis 10, Missouri

Over 400 Authorized Sales & Service Distributors in U. S. A.

District Offices: Atlanta • Chicago • Cincinnati • Cleveland • Dallas Des Moines • Detroit • Indianapolis • Litchfield, Conn. • Los Angeles Milwaukee • Minneapolis • New Orleans • New York N. Kansas City, Mo. • Oakland • Philadelphia • Portland, Ore.

ABSTRACTS

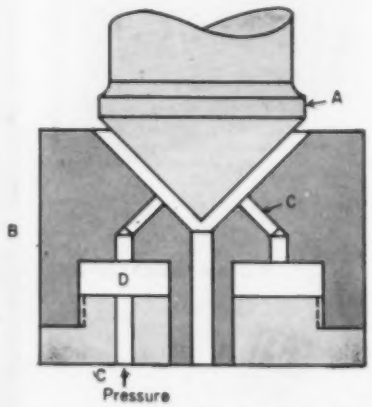
Water Bearings and Air Bearings

Lubricants such as water or air can be fed into a bearing under pressure to ensure a safe load-carrying film of lubricant under all working conditions, including almost zero rpm. These bearings do not compete with the usual slide bearings because their friction moment is proportional to rotational speed. Therefore, their principal field of application is in low speed applications where they show superiority over the conventional bearings.

Conventional slide bearings can no longer retain the hydrodynamic lubricating film at low rotational speeds; thereby reaching a region at which the prevailing lubrication of the parts and of the boundary layer is no longer mechanical but a chemical problem.

A conical bearings which can be operated with water or with air is shown in Fig. 1. The moving shaft pivot A is somewhat raised; the actual bearing gap is only 1/100 to 5/100 mm wide. Lubricant is pumped under pressure at C into the annular space D from which it is distributed to the eight individual holes e, leading to the bearing clearance. Pressure hills are formed over the feeding holes during the flow through the bearing gap and by virtue of the wall resistance, which determines the load carrying capacity.

Pressure drops toward the inner and outer periphery of the bearing shell, down to the pressure of the surround-



(Continued on page 402)

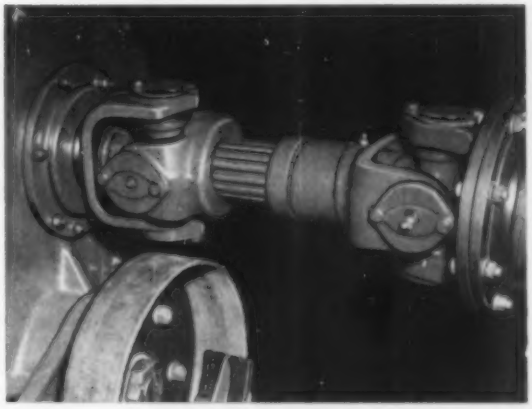
Over swamp, sand and snow, FWD TERACRUZER delivers Fire Power with BLOOD BROTHERS UNIVERSAL JOINTS

Matador guided missiles are transported virtually anywhere by the new Air Force TERACRUZER, designed and built by The Four Wheel Drive Auto Company and equipped with "pillow" tires by Goodyear Tire and Rubber Company.

This revolutionary vehicle required universal joints that could "take it" over the roughest terrain. That's why the builders specified Blood Brothers Universal Joints — known for precision balance, dependability and long life.

You too, will find that on standard or special vehicles — whatever your requirements — Blood Brothers Universal Joints deliver superior performance.

Next time you're up against a universal joint problem, write or call Blood Brothers. Our engineers will gladly cooperate with you.



Selected for this Four Wheel Drive Auto Company project, a dependable Blood Brothers Universal Joint functions off the transmission of the TERACRUZER.

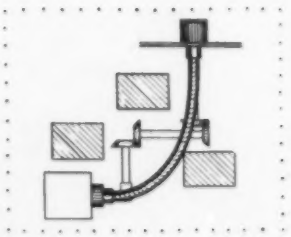
BLOOD BROTHERS MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS
AND DRIVE LINE
ASSEMBLIES

One manufacturer used flexible shafts to replace 35 parts in a Hydraulic Power System . . . cut costs by 90%. Four flexible shafts replaced a 35-part remote-control system . . . simplified design . . . made assembly easier . . . eliminated alignment problems . . . improved performance!

This is only one of hundreds of remote control and power drive problems these quality flexible shafts are solving in every industry today. Can S.S. White flexible shafts help improve *your* product? Perhaps make it lighter in weight . . . cut production costs . . . eliminate unnecessary parts?

If you'd like to know more about flexible shafts, the advice of our engineers costs you nothing. Just write to

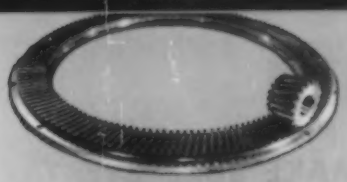


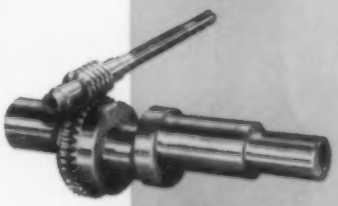
S. S. White Industrial Division, Dept. D, 10 East 40th Street, New York 16, N. Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

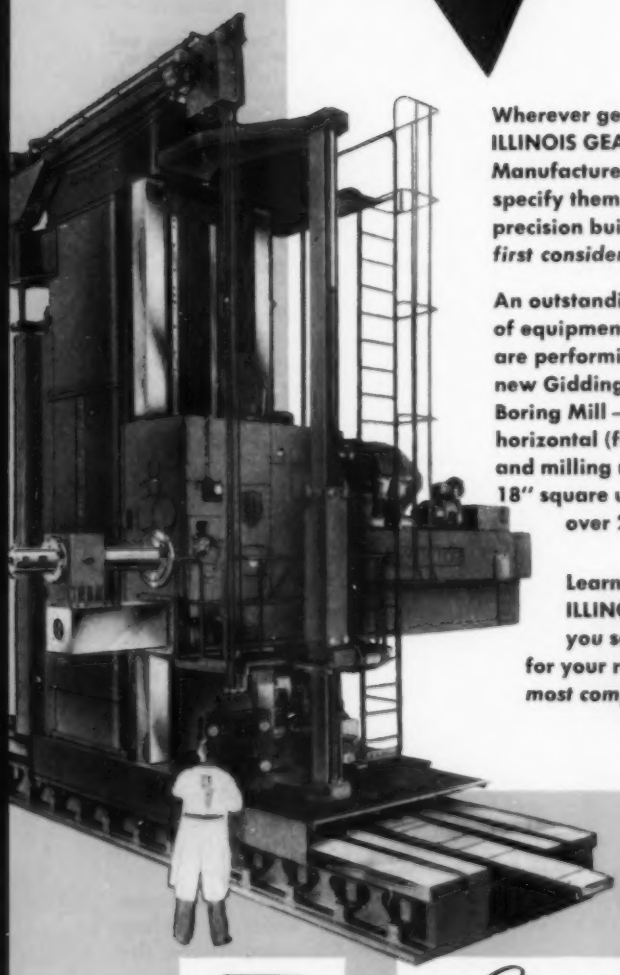
S.S.White
FIRST NAME
IN FLEXIBLE SHAFTS

Useful data on how to select and apply flexible shafts! Write for Bulletin 5601.

Gears For every Purpose





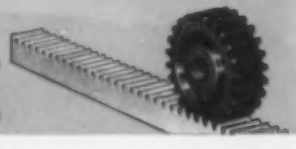


Wherever gears are used, the name ILLINOIS GEAR is known and respected. Manufacturers of fine equipment always specify them. ILLINOIS GEARS are precision built with *quality as the first consideration.*

An outstanding example of the type of equipment in which ILLINOIS GEARS are performing a vital function is the new Giddings & Lewis Model 1210-FUAR Boring Mill — *the world's largest* horizontal (floor type) boring, drilling and milling machine with 10" spindle, 18" square underarm and weighing over 200 tons.

Learn for yourself how ILLINOIS GEAR *can help* you select the right gears for your requirements from *America's most complete line of gears.*

Look for this mark ILLS *the symbol on finer gears*



ILLINOIS GEARS

Reg. U.S. Pat. Off.

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE
CHICAGO 35, ILLINOIS

MAKE SURE EVERY

component*

ADDS MORE

TO YOUR QUALITY PRODUCT

When you specify Ingersoll-Rand* you are certain to get modern design with efficient, economical performance. This is why you'll see reliable Ingersoll-Rand Motorpumps on equipment requiring the best centrifugal pump.

Let us tell you about our most complete line of Motorpumps with built-in dependability and versatility. Write for our latest literature.

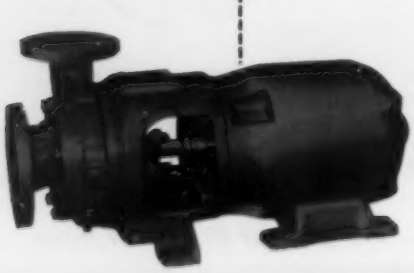
MOTORPUMP

by

Ingersoll-Rand

11 Broadway, New York 4, N.Y.

Sidewall, immersion or foot mounted there's an Ingersoll-Rand Motorpump to suit your requirements.



9-592

ing atmosphere and a second ring of holes or double bearings on the shaft are sometimes used to avoid unsymmetrical loadings.

Bearings of this type have already been proposed in old patents, particularly for suspension of gyro-compasses and applied in practice by the Gyroscopic Instruments Co., Gmbh, Berlin. Tests were performed on a double bearing manufactured by this concern.

A small centrifugal pump forced water from a container into the bearing and tests were made for a working pressure of about 0.5 atmosphere with loads up to 30 Kg, although this load did not represent the limiting load.

The report includes charts and equations for designing the bearing and the possibilities of using air bearings in gyro compasses is briefly discussed.

Abstracted from, "Water Bearings and Air Bearings With Pressure Lubrication," by Fr. Gottwald, Techn. Hochschule Darmstadt, available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C., PB 121405, July 1955, charge per copy is $0.50.

Graduate Study in Mechanical Engineering

The current demand for graduating seniors at our engineering colleges has perhaps obscured more of the developments which have been taking place in postgraduate education. Industry has shown a tremendous interest in advanced education of engineers, and has spent large sums of money on fellowships and on programs designed to encourage engineering employees to undertake graduate study. In view of the accelerating tempo of such company programs, it is appropriate to pause and examine the reasons for graduate study in mechanical engineering. The conclusions reached are as follows.

1) Graduate study in mechanical engineering is no longer regarded as "overspecialization" or as an outlet for academic curiosity. It has achieved a status comparable to that of other scientific fields.

2) There is need for a wider understanding of the utility of graduate study and of the potential value that it has for the entire nation.

3) In the future, graduate students will be given more encouragement and will find more adequate financial

(Continued on page 407)

NOTHING *can equal Stainless Steel*

in its unique combination of properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength, hardness, beauty, cleanability and easy fabrication. For a reliable source of supply, United States Steel offers you the widest range of types, finishes and sizes.

UNITED STATES STEEL CORPORATION, PITTSBURGH
AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

UNITED STATES STEEL

For Sanitation

Food juices are incredibly corrosive, so some restaurants have a lot of trouble in their cold storage rooms because the racks corrode and harbor bacteria. Eastern Steel Rack Company makes racks from Stainless Steel. They are easy to keep clean; and, for all practical purposes, they *never* wear out.

For Corrosion Resistance

This petrochemical extract fractionator was originally made from carbon steel . . . but corrosion ate through the plates and put it out of service in *just two months.* They lined the tower with type 316 Stainless Steel. When examined, the tower had been in service 21 months, and the Stainless was still in good condition.

For Cleanliness

Hawthorne Paper Company, Kalamazoo, Mich., goes to extraordinary lengths to guard against color contamination. Old wooden tanks were thrown out and replaced with Stainless Steel. According to the men at Hawthorne, the Stainless has absolutely no contaminating effect, and it's easy to fabricate.

for dependable power in controls and timing devices

SYNCHRON®
TIMING MOTORS

precision made
accurate
trouble free
tested 51 times
... by HANSEN

the SYNCHRON line
designed, built and tested for long life

8 IN. OZ. STANDARD TIMING MOTOR

Widely used in timing machines, time switches, heating and air conditioning controls, action signs, recording thermometers, and other timing devices. Guaranteed to pull 8 oz. direct load continuously at 1 r.p.m.

20 IN. OZ. HI-TORQUE TIMING MOTOR

Ideal power for timing applications requiring continuous motion. Guaranteed for one year. Instant starting, dependable accuracy, and flexible installations. Guaranteed 20 in. oz. at 1 r.p.m.

UL AND CSA APPROVED

NEW! 1 R.P.H. TIMING MOTOR

Guaranteed to pull 20 in. oz. at 1 r.p.h. (1/60 r.p.m.). Synchron's especially developed motor for slow motion timing applications.

the SYNCHRON line
designed, built and tested for long life

SYNCHRON CLOCK MOVEMENTS

Split-second accuracy and long wearing construction, never needs oiling. Front, rear or bottom set, with or without dustproof case. Simple mounting cuts production and assembly costs.

HANSEN MAGNA-TORC DIRECT CURRENT MOTOR

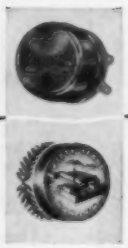
Designed for aircraft instruments and radio controls mechanisms. During World War Two it proved rugged dependability in all altitudes and climatic conditions. Easily adapted to other commercial applications.

"Workhorse of the industry"

Synchron synchronous motors operate smoothly, evenly in any position; at temperatures from −40° to +140° F.; start instantly under load; pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.

Synchron timing motors in all speeds available for prompt delivery.

SYNCHRON®



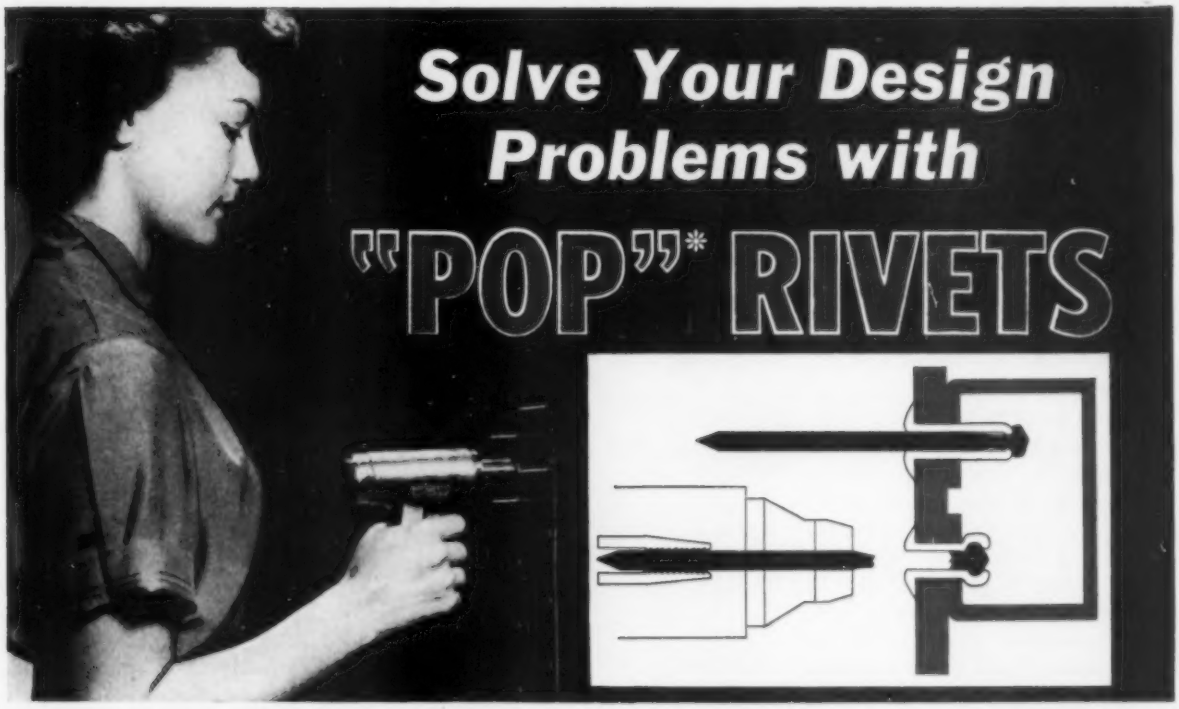
SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, MAGNATORC D.C. MOTORS

HANSEN MFG. CO., INC.
OUR 50TH YEAR

Princeton 5, Indiana

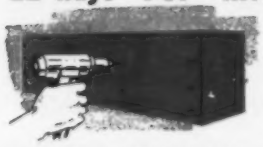
FOR FULL INFORMATION CALL OR WRITE TODAY

THE FROMM CO., 5254 W. Madison St., Chicago, Ill.
R. H. WINSLOW ASSOC., 123 E. 37th St., New York, N. Y.
ELECTRIC MOTOR ENGINEERING, Inc., 8255 Beverly Blvd., Los Angeles 48, Cal. and 3907 Lyon Ave., Oakland, Cal.
H. C. JOHNSON AGENCIES, Inc., Rochester, Buffalo, Syracuse, Binghamton, New York.

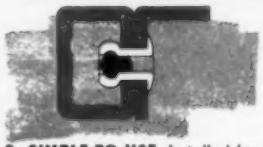


Solve Your Design Problems with "POP"* RIVETS

12 ways "POP" Rivets save money, increase design flexibility, and do a superior job.

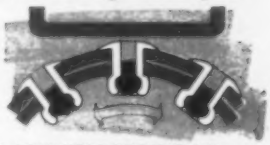


1. LOWER INSTALLED COST. "POP" Rivets can probably save you money even if your present fasteners are FREE.

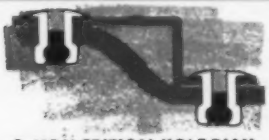


2. SIMPLE TO USE. Installed by one operator from one side "POP" Rivets are so easy to use that a worker can set up to 1200 hourly.

3. HIGH GRIP STRENGTH. Exert as high as 600 pounds gripping pressure between parts.

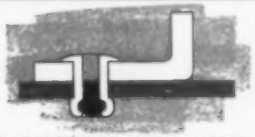


4. LOW HEAD PROFILE. Where space is important, "POP" Rivets' minimum head height is the answer.



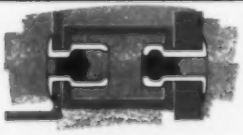
5. NON CRITICAL HOLE DIAMETER. Designer wants holes small, production wants holes larger. "POP" Rivets make both happy.

6. VIBRATION PROOF. "POP" Rivets cannot back out or become loose. No lock washers or nuts required.

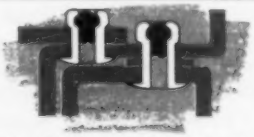


7. PLASTIC TO METAL. "POP" Rivets do not fracture the plastic because it is held in compression.

8. VARIETY OF MATERIALS. Made in aluminum, steel and Monel, in wide range of sizes.



9. THROUGH THICK AND THIN. "POP" Rivets hold tight in thin materials. No threads to strip. Fasten thin sheets or thick and thin with equal ease.



10. GREATER DESIGN FLEXIBILITY. Product design can be made more economical often eliminating separate pieces.

11. CUTS HANDLING COSTS. Bring the rivet to the work — not the work to the fastener.

12. ASSEMBLY LINE FASTENING. "POP" Rivets can be installed at any point. Lightweight, high production tools set rivet. No need for heavy equipment.

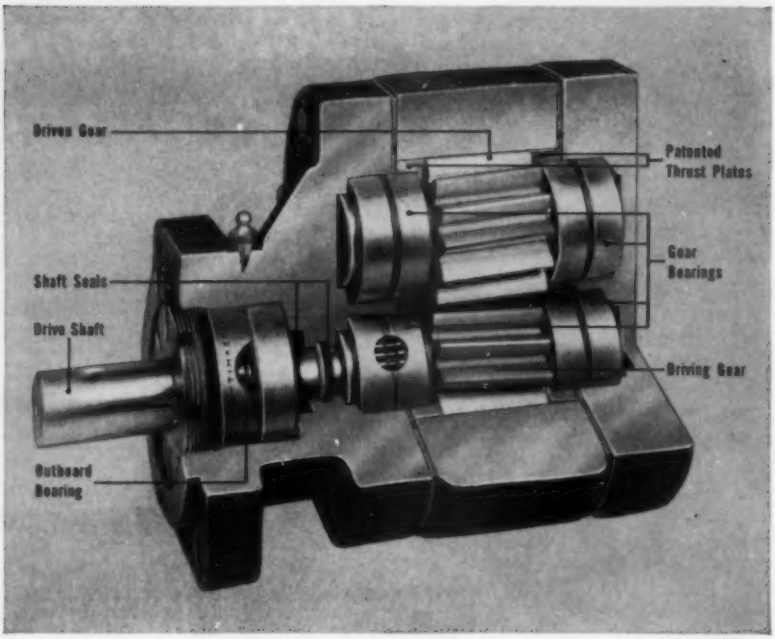
See how "POP" Rivets save time and money, help you solve design problems at our Do-It-Yourself demonstration unit at booth No. 1839.

1957 Design Engineering Show
New York Coliseum
May 20 to 23

*Trade Mark

"POP" RIVET DIVISION
UNITED SHOE MACHINERY CORPORATION
West Medway, Massachusetts • KEystone 3-6611

ADVANCES IN HYDRAULIC PUMP DESIGN



Oil leakage controlled

In any method of mounting an oil-hydraulic pump there is always a certain amount of misalignment between the pump drive shaft and the shaft on the power source. Even where universal drives are utilized there is still the danger of a thrust load. Result in both cases: Flexing is transmitted into the pump seal and eventually to the bearings supporting the gear—leakage around the shaft is a sure-fire bet to follow.

At Commercial, by using an outboard bearing to protect the seals and internal bearings, the common leakage nuisance is eliminated.

Internal alignment perfected

Mass production of independent gear pump housing parts invariably results in varying degrees of internal misalignment—regardless of dowel pin control points used in machining. In many cases the "out" for the problem involves a loosening up on the internal tolerances—with a resultant loss in efficiency.

At Commercial, the patented thrust plate serves as a "natural" alignment control point—is counter bored on its face to match the bearing sleeve, then fits over the bearing sleeve and in turn pilots inside the gear housing. Perfect internal alignment—and increased efficiency—in any Commercial oil-hydraulic pump is axiomatic with rigid inspection of the thrust plate alone.

Constant volume assured

The principle of automatic adjustment of end clearance by internal pump pressure had one main weakness. The full pump pressure was applied against the whole area of each thrust plate. The plates would wear unevenly because on the inlet side of the pump the plate had full pump pressure on one face and a vacuum on the gear side.

By "pressure pocketing" Commercial insured that the pressures on opposite faces of the thrust plates would be in approximate balance around the entire area of the plate faces. Commercial's "one-two" advance design punch—the patented "pressure pocketed" thrust plate—assures constant volume at any pressure and at the same time helps to maintain simplicity of design and soundness of construction . . . provides for longer operating life and no maintenance headaches.

Seizing eliminated

Commercial oil-hydraulic pumps cannot seize because of heat induced by high speed or even inadequately piped systems. Variable end clearance and positive internal alignment make seizing practically impossible. Bearings evenly loaded throughout their length—no corner loading or spawling—are able to withstand much higher operating pressures. They stay in service longer too—regardless of pressures involved.

To take full advantage of tight internal tolerances Commercial designs, produces and grinds its own rotating gears—is able to hold extra close tolerances on tooth contours, outside diameters, and concentricity.

Over 5,000 different pump combinations—port locations and sizes—can be built from Commercial's standard line of oil-hydraulic pump components. A wide variety of drive shafts and mounting combinations are available to solve virtually any individual installation, piping and power application requirement.

Engineering help available

Commercial's oil-hydraulic pump engineering advances are typical of its complete line of oil-hydraulic equipment. The solid technical help Commercial sales engineers can contribute on the application of oil-hydraulic pumps, motors, cylinders and valves may be able to help cut your costs and improve performance.

ENGINEERING DATA FREE

For more information write to Dept. G-18, Commercial Shearing and Stamping Company, Youngstown 1, Ohio. Better yet, send for your copies of Commercial's free engineering reference bulletins. Just check the items below in which you are interested.

- ☐ "Complete Oil-Hydraulic Line Catalog H-7"
- ☐ "Oil-Hydraulic Pumps and Motors Catalog H-4"
- ☐ "Performance Rated Oil-Hydraulic Valves Catalog H-12"
- ☐ "Oil-Hydraulic Cylinders Catalog H-3"

COMMERCIAL
shearing and stamping

support. However, students must be prepared for the hard work and personal sacrifices which graduate study will continue to require. Professional development, like salvation, is an individual matter.

4) The great expansion which has taken place in graduate education has been due to the pressures of the engineering profession, the needs of industry, and the conviction of the students that this was desirable.

5) Further expansion of opportunities for graduate study is needed, and this must be primarily the responsibility of industry. "Incentive" tax arrangements would permit industry to join a fuller partnership from which students, industry, and the nation would benefit.

From "Graduate Study in Mechanical Engineering," by James H. Potter, Stevens Institute of Technology, Hoboken, N. J. Mechanical Engineering, Feb. 1957.

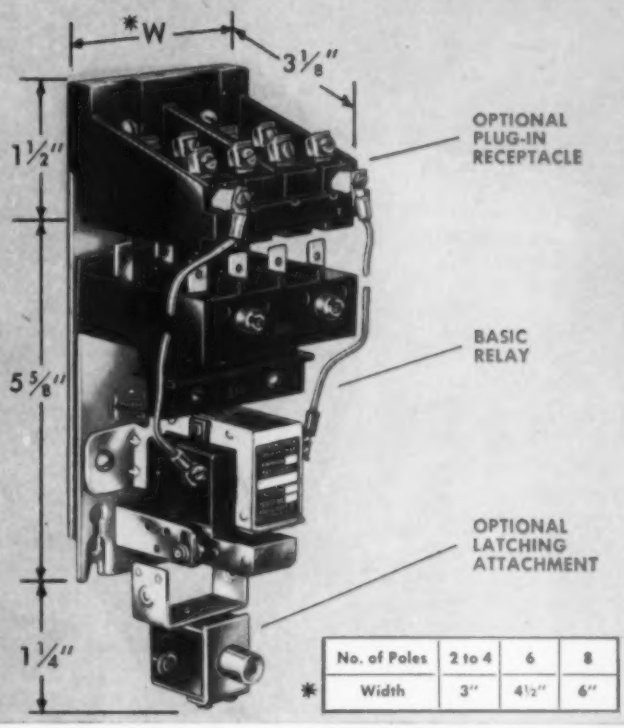
Applicability of Notch Tensile Test Data To Strength Criteria

In notch tensile tests, as in any test to fracture, the results of the test are governed by two phenomena: the initiation of a crack, and separation of the specimen resulting from the propagation of that crack. The first of these phenomena is much better understood than the second; and most of the features of notch tensile testing which make the results intelligible are connected with the "ductility," or the local strain at crack initiation. The nature of the crack propagation, on the other hand, is almost completely obscure; and consequently, although crack propagation is exceedingly important in many applications, such as the failure of welded ships, this aspect of fracturing will not be treated in the following.

There has been very little change in the state of knowledge of notch tensile behavior regarding either new experimental results or general concepts. This paper gives a brief review of the information which currently can be obtained from notched tensile tests, followed by a discussion of the fact that the applicability of this information to manufacturing problems is so limited as to be almost useless for many engineering purposes.

(Continued on page 410)

GREATEST VERSATILITY EVER OFFERED
in a Single Motor Control Design



No. of Poles	2 to 4	6	8
* Width	3"	4½"	6"

New SIZE 00 and 0 RELAYS

600 VOLTS AC 10 and 15 AMPS
2 • 3 • 4 • 6 • 8 POLES

OPTIONAL PLUG-IN RECEPTACLE . . . minimizes down-time on high output machines; relay speedily replaced *without* disturbing wiring.

EASIEST CONTACT CONVERTIBILITY . . . from normally-open to normally-closed. No tools needed.

SIMPLIFIED FRONT REMOVAL OF COIL . . . fastest, easiest method of removing coil ever devised. Just remove 2 screws, swing to front, and lift out entire assembly.

HANDIEST LATCHING ATTACHMENT . . . another A-H exclusive, allows quick conversion to latching type relay . . . the *only* such single attachment quickly convertible in the field from "latch-in" to "latch-out" or "latch-in-and-out."

Available with AC and DC holding coils.

For complete information, write to The Arrow-Hart & Hegeman Electric Company, 103 Hawthorn St., Hartford 6, Connecticut.

ARROW AH HART
Quality since 1890
MOTOR CONTROLS • ENCLOSED SWITCHES
APPLIANCE SWITCHES • WIRING DEVICES

ARROW AH HART

How to produce appliances with a built-in polish

Stainless is the one metal that maintains its beauty from plant to purchaser. Consumers appreciate its lifetime sparkle . . . carefree durability . . . ease of cleaning . . . substantial feel. And you'll like the clean, dependable way that you can work and form Crucible stainless.

Why *Crucible* stainless? Among the many good reasons are: ***Uniformity*** — strip and sheet unsurpassed in flatness and close tolerance control. ***Finish*** — fine finishes, in a wider choice. ***Fast Supply*** — wider assortment of grades, sizes, shapes — all available promptly through nearby Crucible warehouses.

Join the switch to Crucible stainless. You and your customers will be glad you did. Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.

Write for a free copy of the "Crucible Stainless Fabricator's Handbook".

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

NOW

a new STEAM valve with all the Rockwood Ball Valve advantages!

The new Rockwood Bronze Ball Valve for use with steam offers you many unusual benefits.

It Handles up to 125 Pounds of Steam per square inch and 350°F, with ease.

It's Leakproof — even after continued use Rockwood Steam Ball Valves stay dry.

It Opens and Closes Quickly — only a quarter turn is needed to open or close Rockwood Ball Valves.

It Has Longer Wear-Resistance — chrome-plated bronze ball withstands abrasion, scratching and pitting.

Rockwood's new Ball Valve for use with steam comes in pipe sizes from ⅜" up to 2". Send coupon for full information and data. Distributors in all principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
1312 Harlow Street
Worcester 5, Mass.

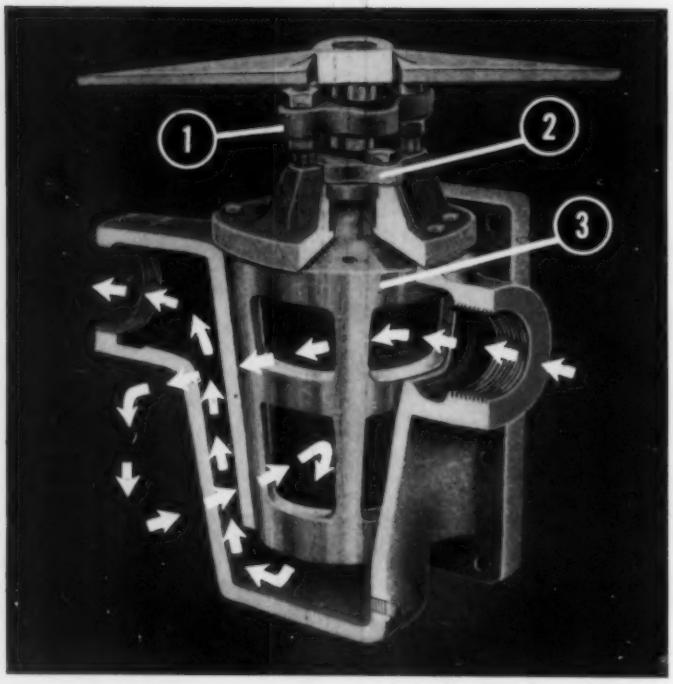
Send me illustrated folder on Rockwood's new Ball Valve for use with steam.

Name.....

Title.....

Company.....

City.....Zone..State.....



(1) Locking flange (2) Gland (3) Valve plug

NEW! Kraissl Class 72 Valve Simplifies Control of Non-Interrupted Flow

Originally designed and job-proven as the center section of our own Class 72 separator, this valve permits diversion of 2-way flow from one chamber to another—***without shutting down***. The single-unit installation eliminates costly, cumbersome piping and fittings.

Simple, hand-turning of tapered, non-wedging valve plug re-routes flow into alternate chamber of system. Continuous-flow design of valve plug ***absolutely insures against shut-off***. The Class 72 valve assembly is ideal for heat exchanger and similar applications where uninterrupted flow is mandatory.

Pressure ratings to 600 psig with standard line; Special valves for higher pressures.

Write for technical bulletin A-1869

KRAISSL KRAISSL CO Inc

289 Williams Ave. Hackensack, N. J.

Finally, there is a consideration of what kind of information is necessary for rational design, and how such information might be obtained.

Abstracted from, "On the Applicability of Notch Tensile Test Data to Strength Criteria in Engineering Design," by J. D. Lubahn, Schenectady, N. Y., Transactions of the ASME, Paper No. 55-A-149, Jan. 1957.

Design Data for Reinforced Plastics

A summary of the types of data required is presented together with brief explanations of why such data are needed. Static strength properties, temperature effects, and time-dependent properties under both static and dynamic loads, are reviewed together with thermal property data. Some data are presented to indicate available strength properties of phenolic, polyester, epoxide and silicone laminates. The large quantity of data necessary is reviewed as well as possible methods of supplementing available data. The materials for which data are presented do not necessarily reflect the most recent materials advances, but were selected on the basis of availability of test data.

Abstracted from "Design Data For Reinforced Plastics," by Capt. William E. Dirkes, Materials Laboratory Directorate of Research, Wright Air Development Center, Air Research & Development Command, USAF, Wright-Patterson Air Force Base, Ohio. Presented at Twelfth Annual Meeting Reinforced Plastics Div., Edgewater Beach Hotel, Chicago, Ill., Jan. 1957.

Creativity and Engineering Education

A number of books and many articles in the popular journals have been written offering advice to individuals on how to develop and use their creative potential, suggesting creative exercises and activities as a means of stimulating the use of the imagination. Several colleges have also recognized the value of attempting to stimulate the full use of the imagination, and as a result various courses have been offered with this object in mind.

Realizing that progress depends on creative accomplishments, many large corporations have instituted creative training programs and have adopted creative conference techniques, popu-

(Continued on page 415)

Your forging problem is our business. Enthusiastic engineers at AmForge consider each project a new challenge —a challenge to *adapt* AmForge facilities and know-how to your problem. For example, the adjustment rack on a railroad switch stand above was once made as a casting. Although the design more readily adapted itself to casting methods, it was proved that it could be forged. The result was more uniformity, reduced machining hours and less scrap. Being stronger as a forging, the net weight of the part was reduced. Even the serrations are forged. Ask us for an AmForge Adaption Analysis. Phone, write or send the coupon at right.

AMERICAN Brake Shoe COMPANY

AMFORGE DIVISION

150 N. Wacker Dr., Chicago 6, Illinois
PLANTS: CHICAGO, ILLINOIS • AZUSA, CALIFORNIA

NEW CATALOG
Mail coupon today

This new 16-page book will give you complete information about AmForge facilities. Send the coupon for your copy today.

AmForge Division, Dept. PE-5
150 N. Wacker Drive
Chicago 6, Illinois

Please send me _____ copies of your new catalog.

*Name*_____

*Position*_____

*Company*_____

*Street*_____

*City*_____ *Zone*___ *State*_____

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Factor of Safety— make it a reality

You can't calculate that with a bolt having yield strength of 4 times the working load you're automatically getting a *safety factor* of 4. Far from it. Only when the bolt is *tightened* to four times working load do you get it.

That's because rigidly fastened members can be externally loaded to the full value of residual tension in bolts without any separation or extra bolt stress.

Suppose you need a bolt for a 5000 lb. working load. For a X4 safety factor, you use a bolt of 20,000 lb. capacity, and tighten it to 20,000 lb. tension. If you tighten to only 10,000 lbs., any external load larger than this causes loosening, and progressive bolt failure from fatigue. So your safety factor is really only 2.

PRODUCTION MAN FOLLOW-THROUGH IMPORTANT

Factor of safety, then, is not established on the drawing board. It can only be put into the product by the shop man with wrench. In short, a bolt is no better than the supervision of its tightening.

A NOTE ON FLEXIBLE JOINTS

This case is different. You tighten such a joint just to working load. So use a bolt capable of this *plus* any added stress *multiplied* by your safety factor.

How to simplify bolt and nut usage

DESPITE their now unified dimensions, "standard" fasteners number thousands upon thousands of different types and sizes. More and more companies are beginning to realize that *usage* simplification offers advantages.

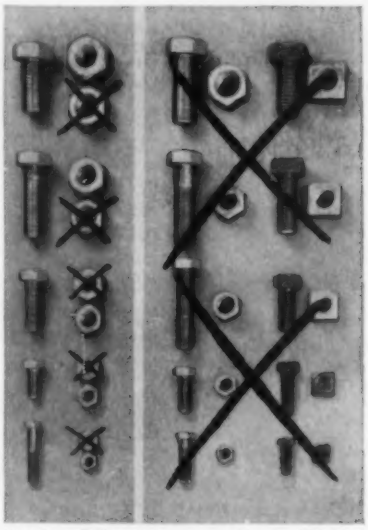
EXAMPLES

A well known electrical manufacturing company finds it no handicap to eliminate all 1/16" bolt sizes above 3/8", thereby simplifying production and purchasing.

One engineering firm eliminated 1700 different fastener items from inventory by determining that the jobs could be done as well by other sizes or types.

SOME SUGGESTIONS

To guide your thinking, RB&W points up the following ways to simplify: (1) Forget thread fits for all but specialized needs – standard "tolerance fits" have thoroughly proved themselves. (2) Why adhere to double thread standard when coarse threads prove stronger and assemble faster? (3) Stick with hex head bolts – they do better jobs than square. (4) It can save money to change diameter or length, rather than to add another item to stock. (5) Two standard physical grades meet most load range requirements – do you really need special alloys? (6) Heavy nuts really belong with larger size bolts – use finished nuts with the smaller sizes.



Here is a graphic display of possible simplification. From a typical array of fasteners, it shows what may be superfluous for meeting the requirements of proper fastening in a great many instances.

RB&W would be happy to enlarge on these facts, and help you simplify fastener selection to get proper joint strength and cut assembly time and inventory. Write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

High strength bolts save costly crane

At one company's plant, a large, heavy-duty crane had deteriorated due to rivets loosening. Replacing with new rivets was no permanent answer, but RB&W high tensile bolts were.

Used with hardened washers, these RB&W bolts clamp members together so tightly, no slipping into bearing takes place, holes are reinforced against fatigue, and connections become vibration-proof.

Assembling heavy duty equipment with RB&W high strength bolts in the first place can avoid such problems and create more satisfaction with the product.

A NEW APPLICATION GUIDE

by Century to help you select Electric Motors

This handy Guide is carefully planned to make it easy for you to select electric motors for all popular applications. Using the convenient tables inside, you simply start with the equipment or machinery you want to drive.

Then, you identify the character of the load, starting and running torques, frame type, speed, etc., to arrive at precisely the right motor for your specific application. In just a few moments you know the motor type you need, the dimensions and other pertinent data.

Because Century offers a complete line, this handy manual will guide you to the right motor for your application. Obtain your own copy of this 12-page reference manual.

Visit Booth No. 922, Second Floor, Design Engineering Show

MAIL COUPON TODAY FOR YOUR FREE COPY

CENTURY ELECTRIC COMPANY
1806 Pine St., St. Louis 3, Mo.

Please send me the new Century Application Guide CE-99.

Name.....

Company.....

Address.....

City..... Zone..... State.....

995

Performance-Rated ©
MOTORS
1/20 to 400 HP

C CENTURY ELECTRIC COMPANY

1806 Pine Street • St. Louis 3, Mo. • *Offices and Stock Points in Principal Cities*

4 NEW design aids providing working data for every ELECTRONIC CABLE Problem

... available from Pacific Automation Products, a company established to provide a product as well as a service, which utilizes a 50,000 sq. ft. factory and an experienced staff of qualifed engineers and technicians to design, manufacture and install custom made neoprene jacketed cable for the vast electronic industry.

Engineers and technicians are invited to investigate career opportunities with us. Submit resume for interview.

CABLE SPECIFICATIONS

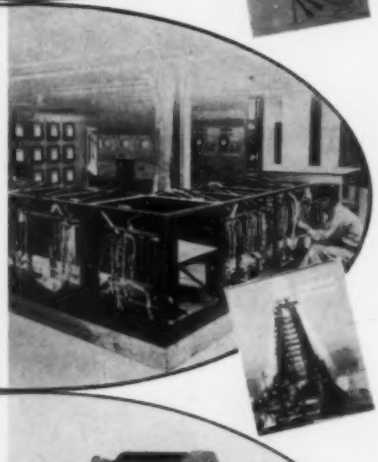
"Design Engineering Specification" Bulletin No. PAP-C-101. Comprehensive 19-page engineering manual describing materials, construction, design criteria, specification conformance, performance, identification, documentation and other important features determining correct cable for your specific application.

CABLE AS A COMPONENT

"Electronic Cable as a Systems Component" Bulletin No. 656. Generously illustrated pamphlet describes design and production of electronic cable in bulk and assemblies. Connectors and hardware; cable breakouts; environmental requirements; voltage rating, testing; cable procurement data – are some of the subjects covered in this bulletin.

CABLE SYSTEMS

"Engineered Cable Systems" Bulletin 357. Illustrated brochure describing Pacific Automation Products' pioneering in the use of the Systems Concept to coordinate cable design with the development of complex electronic systems. Liaison engineering teams cooperating with systems design groups establish cable as integral part of system, supervising cable construction concurrently with development of other elements.



CABLE ACCESSORIES

"Extension and Adapter Sleeves for Cable/Connector Compatibility" Bulletin 257. Illustrated bulletin on aluminum adapters designed and manufactured by Pacific Automation Products, which for the first time provide a means of attaching any size AN connector to any size cable, with assured reliability.

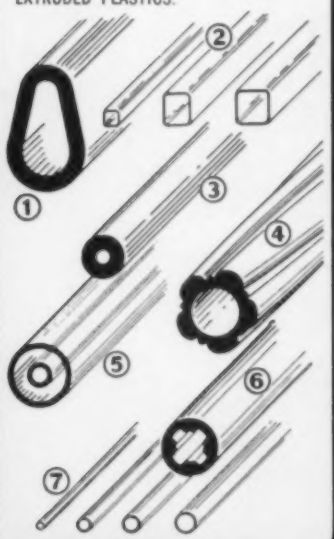
Pacific Automation Products, Inc.
CHapman 5-6871 • TWX: GLN 7371

1000 AIRWAY, GLENDALE 1, CALIF.
137 Walnut Hill Village, Dallas, Texas • Fleetwood 2-5806

ANCHOR PLASTICS EXTRUSION NEWS

TUBULAR SHAPES

Several interesting applications of hollow extruded sections are: 1) Radio Handle; 2) Relay Coil Core Form; 3) Battery Vent; 4) Electric Candle; 5) Air operated Water Pump; 6) Mechanically operated revolving Core; 7) Miniature Bore Precision Tubing. You can get ideas about applications for extruded parts by reading our brochure EXTRUDED PLASTICS.



We extrude to YOUR specifications any SHAPE, ROD, TUBE or MOULDING; also CURVED EXTRUSIONS*, FABRICATED EXTRUDED PARTS, in any of 12 plastic materials:

- Extrusion dies made in our tool room, usually between $45-$200
- Send us your prints for quotation
- Write for your copy of Extruded Plastics on company letterhead

PAT.

ANCHOR PLASTICS CO., INC.
36-36 36th Street
Long Island City 6, N. Y.

Visit us at Booth 319, Design Engineering Show N. Y. Coliseum—May 20-23, 1957

larly called brainstorming sessions, to develop solutions for suitable problems. These group techniques can be very effective, but they are not suitable for all types of problems. The problems requiring creative work on the part of individuals are still neglected. In addition, it should be recognized that these techniques are designed primarily to overcome the extremely critical attitude developed in the schools, an attitude which hampers the full use of the imagination required for creative work.

The stifling of the imagination is started in the elementary schools, continued in the high schools, and perfected in our colleges. Too many recent graduates think the answer to every problem should be found in one of their textbooks or a handbook. If the answer cannot be found, there must be no answer. The thought of trying to use fundamentals to find an answer never enters young engineers' minds.

It appears that the present methods of engineering education are not only neglecting the development of creativity, but are developing judicial or negative attitudes which must be overcome if an engineer is to make full use of his imagination. Perhaps creative exercises should be incorporated throughout the present courses to develop inquiring minds capable of analyzing, solving, and presenting the solutions to real problems with a minimum of readjustment for the demands of professional practice.

Abstracted from, "Creativity and Engineering Education," by H. L. Shulman, Clarkson College of Technology, Potsdam, N. Y., Journal of Engineering Education, Dec. 1956.

Disturbances Due To Bearing Oil Films

Two flexible rotors (65 lb and 130 lb) having critical speeds of about 1300 rpm were run in six journal bearings. Bearing clearance ratios were two and four mils. Bearing diameters were 2 in. Length to diameter ratios were one half, three quarters and one. Unit bearing loads were between 8 psi and 32 psi. With few exceptions, whirl-impending speeds were very near twice critical and a slight decrease in whirl impending speed was noticed

(Continued on page 418)

assistant ENGINEER available

His name is STANPAT, and though he is not human he can swallow up your tedious re-drawing and re-lettering of standard and repetitive blueprint items for 24 hours a day if need be—without tiring. STANPAT is the remarkable tri-acetate sheet that is pre-printed with your specification and revision boxes, standard symbols, sub-assemblies, components and cross-sections . . . with adhesive front or back, waiting to be pressed into position in 15 seconds! Reproductions are unusually crisp and clear, guaranteed not to wrinkle, dry out or come off. STANPAT saves hundreds of hours in drafting time and money, allowing the engineer more time for creative work.

Already employed in numerous firms, STANPAT can go to work for you, too! Send us your drawing details now for quotation and free sample, no obligation.

so simple
1 to use:
PEEL the tri-acetate adhesive from its backing.
2 PLACE the tri-acetate in position on the tracing.
PRESS into position, will not wrinkle or come off.
3
STANPAT CO.
Whitestone 57, N. Y.
U. S. A.

STANPAT CO., Whitestone 57, N. Y., U. S. A.
Phone: FLushing 9-1693-1611

☐ Please quote on enclosed samples. ☐ Kindly send me STANPAT literature and samples. Dept. PE-5

Name_____

Title_____

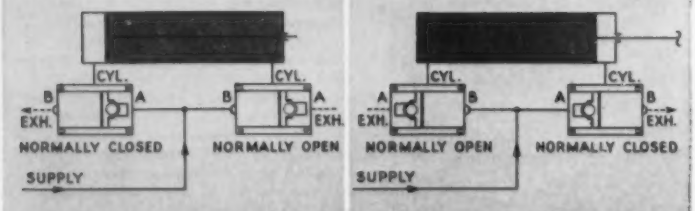
Company_____

Address_____

Simplified piping

Another Plus Value in NOPAK-MATIC poppet-type air control valves

3-WAY NORMALLY OPEN OR NORMALLY CLOSED

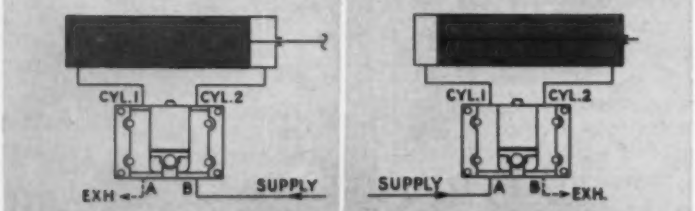


Simply pipe to proper port . . . no change in valve necessary

Piping supply to Port "A" provides Normally Closed operation — supply to Port "B" Normally Open operation. There are no changes to make in the valve . . . just pipe to the proper port. All 3-Way valves have two cylinder outlet ports for piping convenience.

The exclusive Nopak-matic "Flow-Director" pilot head automatically selects pilot pressure from whichever port is used as inlet. It eliminates purchasing special valves for each application or re-assembling of parts.

ELIMINATE CRISS-CROSS PIPING OF 4-WAYS



Simply pipe to proper port . . . no change in valve necessary

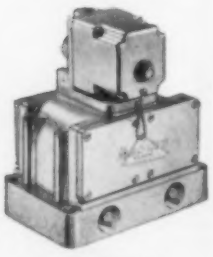
All Nopak-matic 4-Way valves can be piped with pressure to Port "A" or Port "B". Here again, the "Flow-Director" pilot head automatically selects pilot pressure from the inlet port. Flow through the valve is thus changed to meet the application requirements . . . eliminates criss-cross piping to the cylinder. There are no changes to make in the valve . . . just pipe to the proper port.

NOPAK-MATIC Plus Value Valves are available in ¼", ⅜", ½" and ¾" pipe sizes, for 2- or 3-Way Normally Open or Normally Closed operation with master (air), single or double solenoid pilot control heads.

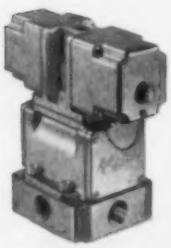
300 SERIES
2,- 3-Way
Master Valves

400 SERIES
4-Way
Master Valves

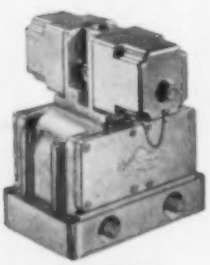
310 SERIES
2-, 3-Way
Single Solenoid
Pilot Operated



410 SERIES
4-Way
Single Solenoid
Pilot Operated



320 SERIES
2-, 3-Way
Double Solenoid
Pilot Operated



420 SERIES
4-Way
Double Solenoid
Pilot Operated

NOPAK-MATIC valves meet *all* J.I.C. Standards

NOPAK VALVES and CYLINDERS

GALLAND-HENNING NOPAK DIVISION • 2762 South 31st St. • Milwaukee 46, Wis.

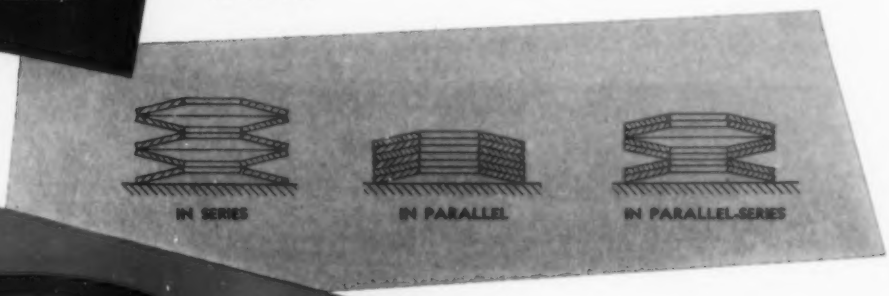
Catalog 105 describes in detail all the Nopak-matic Plus Values and gives complete dimensions, installation and parts data. Send for your catalog now. It will be forwarded promptly.

Belleville Springs

Solve Spring Problems of HIGH LOADS in a Limited Space

This useful type of spring may be the answer to your need where space and load requirements are a problem. Made to any diameter or thickness—can be stacked in series, parallel, or parallel-series, or as an "Energy* Cartridge." The experience of our engineers is available in a pamphlet, "Belleville Washers." Write for your copy.

See these and other developments—Booth 205 Design Engineering Show



WALLACE BARNES COMPANY, BRISTOL, CONNECTICUT

The WILLIAM D. GIBSON COMPANY, 1800 CLYBOURN AVE., CHICAGO 14, ILL.

RAYMOND Manufacturing COMPANY, CORRY, PENNSYLVANIA

BARNES-GIBSON-RAYMOND, 40300 PLYMOUTH RD., PLYMOUTH, MICH.

B-G-R COOK PLANT, ANN ARBOR MICHIGAN

DIVISIONS OF ASSOCIATED SPRING CORPORATION COAST TO COAST

SEABOARD Pacific Div., 15001 S. BROADWAY, GARDENA, CALIF.

OHIO DIVISION, 1825 EAST FIRST ST., DAYTON, OHIO

WALLACE BARNES COMPANY, STATE FAIR BLVD., SYRACUSE 9 (Salina), N.Y.

MILWAUKEE DIVISION, 341 E. ERIE ST., MILWAUKEE, WIS.

DUNBAR BROTHERS COMPANY, BRISTOL, CONN.

F. H. NAHROSS AND SONS CO., BRISTOL, CONNECTICUT

THE WALLACE BARNES CO., LTD., HAMILTON, CANADA

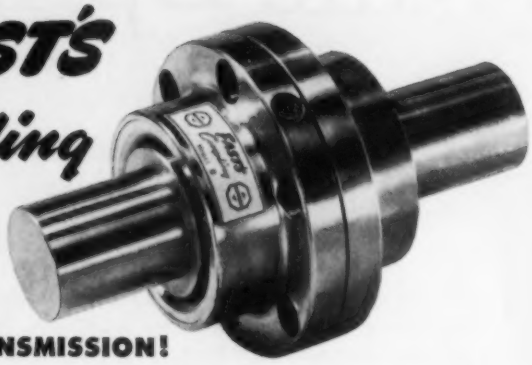
Divisions of

ASSOCIATED SPRING CORPORATION

GENERAL OFFICES: BRISTOL, CONNECTICUT

The incomparable Model B

FAST'S Coupling



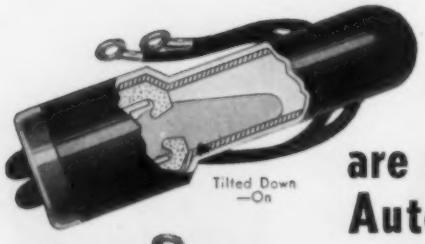
LOW-COST POWER TRANSMISSION!

Designed for light and medium drives—fans, blowers, pumps—a lighter, smaller and lower priced Fast's Coupling! The same famous features found in all Fast's Couplings . . . the same mechanical flexibility, the same positive lubricating principle, the same rugged construction and trouble-free performance . . . the same highly efficient power transmission which has made Fast's Couplings the leader for more than 30 years! Available for shaft sizes up to 2⅝" and sold with Koppers' free engineering service. For the low-cost solution to your shaft coupling problem, write: Koppers Company, Inc., *Fast's Coupling Dept.*, 7105 Scott Street, Baltimore 3, Md.

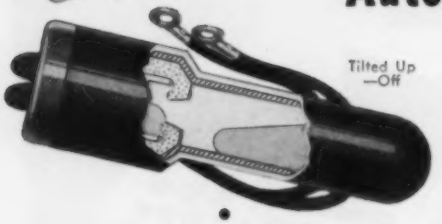
THE ORIGINAL

KOPPERS **FAST'S Couplings**

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans, Gas Apparatus. *Engineered* Products Sold with *Service*.



DURAKOOL Tilt Switches are the Life of your Automatic Controls



This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

MILLIONS OF CYCLES WITHOUT FALTERING

See telephone directory for local distributor, or write.

DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.
700 WESTON RD., TORONTO 9, CANADA

Durakool ALL-STEEL MERCURY *Switches*

with decreasing viscosity. No stable range was observed above the speed at which whirl set in.

A method for determining the running position of a journal bearing by photographic means is described and several determinations of running speed position are presented. The ratio of the maximum stable speed to the critical speed is plotted as a function of inlet oil viscosity. Also, some interesting trends of whirl-impending speed with L/D ratio, clearance and temperature are presented.

Abstracted from "A Further Investigation of Disturbances Due to Oil Films in Journal Bearings," by John F. Lewis and Graham B. Fulton, Rensselaer Polytechnic Institute, Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C., PB121519, May 1956.

Antiwear and Extreme Pressure Additives for Greases

Twenty-seven different compounds or formulations have been incorporated in amounts up to 10% in lithium soap mineral oil greases. These greases were evaluated by means of the Shell four-ball wear, the Shell four-ball extreme pressure, the Falex, the Cincinnati stick-slip, and the Timken testers. The results of these tests are tabulated according to type of additive used. The additives used were made up of commercial gear lubricant additives, oiliness improvers, a recognized antiwear agent and compounds which from their composition looked promising. The active elements present were lead, sulfur, phosphorous or chlorine and were evaluated alone and in various combinations.

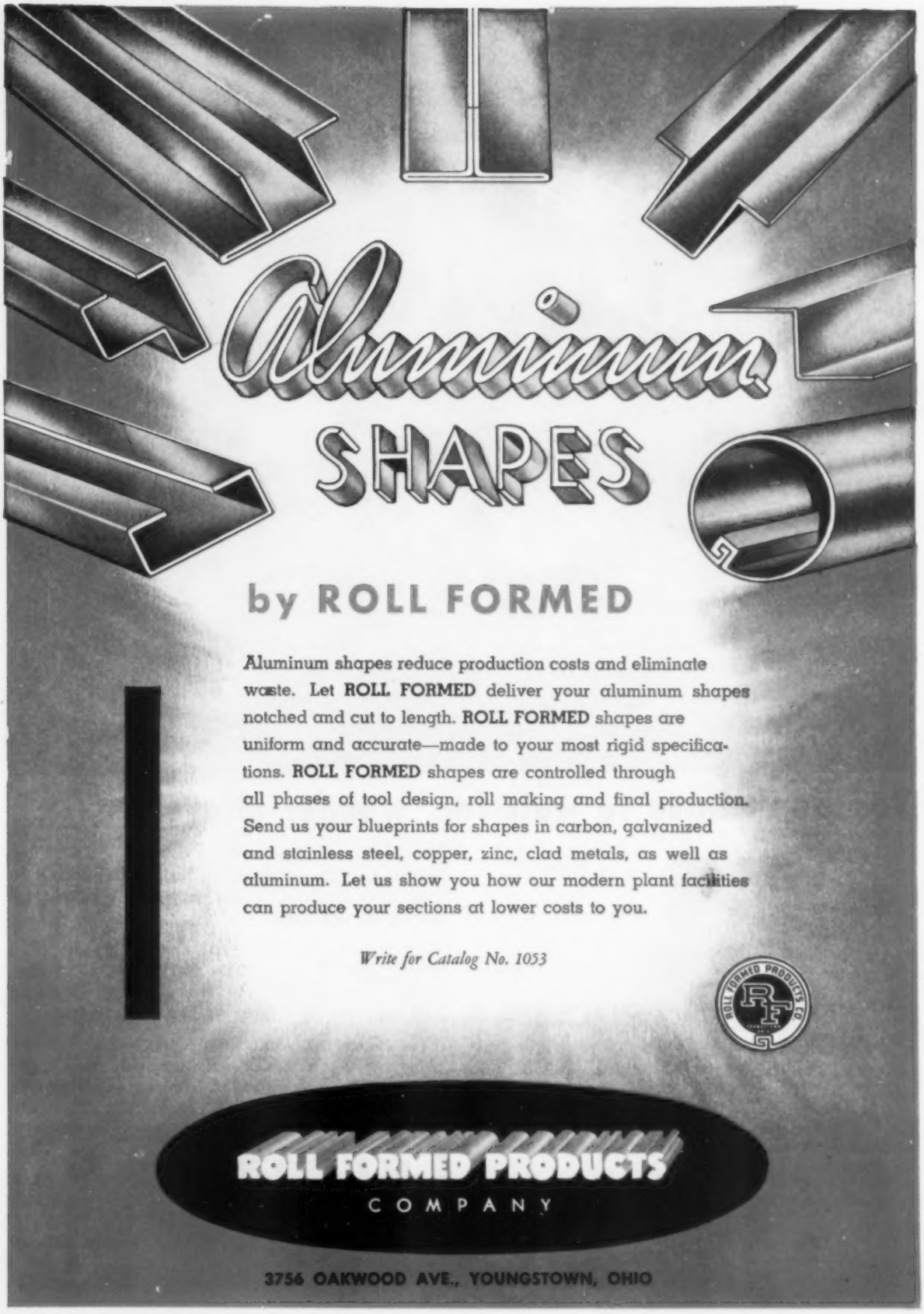
No definite statements are possible from results of this investigation because of inability to secure a definite correlation between the various tests. It is possible to indicate some general trends, however, such as:

Phosphor-containing additives gave better antiwear properties to greases than any other type.

Sulfur-containing additives were superior to the others for extreme pressure properties.

Chlorine-type additives exhibited better extreme pressure than antiwear

(Continued on page 422)


Aluminum
SHAPES
by ROLL FORMED
Aluminum shapes reduce production costs and eliminate waste. Let ROLL FORMED deliver your aluminum shapes notched and cut to length. ROLL FORMED shapes are uniform and accurate—made to your most rigid specifications. ROLL FORMED shapes are controlled through all phases of tool design, roll making and final production. Send us your blueprints for shapes in carbon, galvanized and stainless steel, copper, zinc, clad metals, as well as aluminum. Let us show you how our modern plant facilities can produce your sections at lower costs to you.
Write for Catalog No. 1053
ROLL FORMED PRODUCTS
COMPANY
3756 OAKWOOD AVE., YOUNGSTOWN, OHIO

You don't have to wait for "wonder alloys"

Complete information on Carpenter High Nickel Alloys is contained in the most authoritative and useful set of booklets ever published on this type of alloys. We'll be glad to see that you get the data you need if you'll drop us a line on your Company letterhead.

Remarkable temperature compensation, controlled low expansion, high permeability, predictable response to very weak electrical signals, improved glass-to-metal sealing are here today.

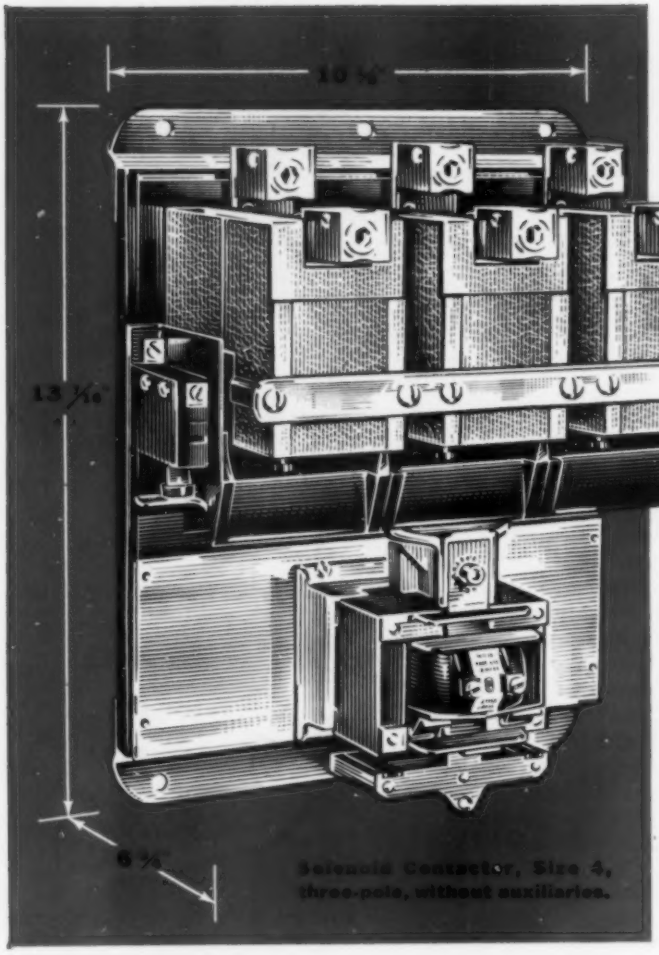
In miniaturization, instrumentation, electronics . . . wherever the push is on to make products smaller, lighter, more accurate . . . new challenges are being met every day by Carpenter High Nickel Alloys.

Today, Carpenter has the most complete line of proven alloys available for these specialized applications. Let's discuss their part in your present and future NOW!

Carpenter STEEL

high nickel alloys

The Carpenter Steel Company, 117 W. Bern St., Reading, Pa.
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"



Solenoid Contactor, Size 4, three-pole, without auxiliaries.

NEW 150-amp solenoid contactor extends proven line

This new Size 4 A.C. solenoid contactor is ideal for use in motor starters and controllers for main line, accelerating and reversing purposes and for resistance heating and lamp loads as well.

It's the new Bulletin 4454—incorporating many advanced design features found on Ward Leonard's Sizes 0 to 3 contactors. Check these outstanding features:

New sintered-silver-cadmium-oxide contacts—can repeatedly handle high inrush currents without a sign of contact welding, excessive pitting or other damage.

Simple, compact solenoid design—excellent for modern metal control panels using accessible front-of-board wiring, particularly useful where panel space is limited.

Available with two or three main poles and up to 4 side-mounted auxiliaries. Also with provision for mechanical interlocking and addition of overload relays.

Completely described in Bulletin 4454. Write for your copy today. The Ward Leonard Electric Co., 63 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 7.6

ENGINEERING DATA

Size 4 A.C. Contactor Ratings*

Service	8-Hour Ampere Rating		Enclosed Power Rating	
	Open	Enclosed	Three Phase Volts	H.P.
Across-the-Line Starting	150	135	110 220 440-550	25 50 100
Across-the-Line Plug-Stop or Jogging	150	135	110 220 440-550	15 30 60

Service	8-Hour Ampere Rating	Single Phase Volts	Single Phase K.W.	Three Phase Volts	Three Phase K.W.
Resistive Heating Load**	150	110 220 440 550	15 30 60 75	110 220 440 550	26 52 105 130
Tungsten Lamp Lighting or Infrared Heating Load**	120 Amperes for 250 Volt Circuits or Less				

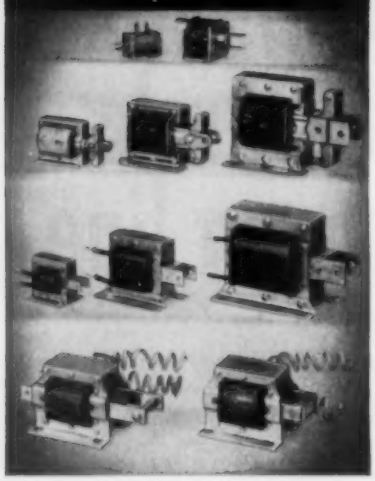
*The ratings listed are those recommended by the National Electrical Manufacturers Association.
**These ratings apply to open or enclosed contactors.

LIVE BETTER...*Electrically*

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

Now...
FOR THE FIRST TIME A COMPLETE LINE OF CUSTOM-DESIGNED SOLENOIDS AVAILABLE FROM STOCK

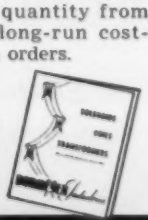


The line consists of 17 models to provide 34 widely differing specifications . . . delivery can be made within 24 hours of receipt of order . . . specifications include: pull and/or push capacities up to 45 lbs., . . . sizes from ¾"x 1⅛" to 3"x 3"... stroke lengths fractional to 2".

All solenoids are built to rigid standards of highest custom quality. Double shading coils provide high sealed pull without excessive AC hum. Electrical characteristics are thoroughly uniform. Units are compactly engineered to extremely close tolerances. Rugged construction provides long service-life under the most strenuous conditions.

All solenoids in the line can be supplied in any quantity from single units to long-run cost-saving production orders.

Request complete information. Ask for catalog.



DORMEYER INDUSTRIES

3414 N. Milwaukee Avenue, Chicago 41, Illinois

properties, but were inferior to either sulfur or phosphorous in both characteristics.

It was possible to blend two or more type of additives and attain both antiwear and extreme pressure improvements.

Optimum antiwear and extreme pressure qualities depend upon factors not contained in the additive, such as oil viscosity, soap type and amount, and probably upon the conditions of service. It is, therefore, probable that the most efficient antiwear and extreme pressure greases will be tailor-made for a particular machine or type of usage and no doubt will be compounded by careful balancing of the several factors responsible.

A study of all factors effecting wear is necessary before much progress can be made in preventing it. Factors which should be considered are oil type and viscosity, soap type and amount, additives, and even the type of machine and the metals which are in sliding or rubbing contact.

Serious consideration should also be given to the various tests used. The fact that several investigations have failed to secure correlation between the different tests suggests that there are undiscovered factors entering into the problem of wear. As long as some factor remains unaccounted for, any attempt to prevent wear will at most be mainly speculative.

Abstracted from, "Antiwear and Extreme Pressure Additives for Greases," by S. Fred Calhoun, and G. P. Murphy, available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C., PB 111919, March 10, 1955, charge per copy is $0.75.

Brittle Fracture Propagation in Wide Steel Plates

It is well known that steel may fracture in a brittle manner under certain conditions. In many applications today, the probability of brittle fracture may be minimized by giving attention to such variables as type of material, geometry, temperature and stress level.

Also, in selected applications, it is now possible to use effectively crack arrestors, which may retard or stop the propagation of a brittle fracture. This progress is the result

(Continued on page 426)

New Solutions to Design Problems:

MACHINED CARBON PARTS BY *Speer*

If you are designing new products ... or are searching for a more efficient material for existing products ...consider carbon parts—machined by Speer.

Versatile and economical ... carbon products machined by Speer range from feather-light resistors to 1300-pound electrodes.

Speer carbon may help you improve product performance... reduce unit costs. Write today for full details.

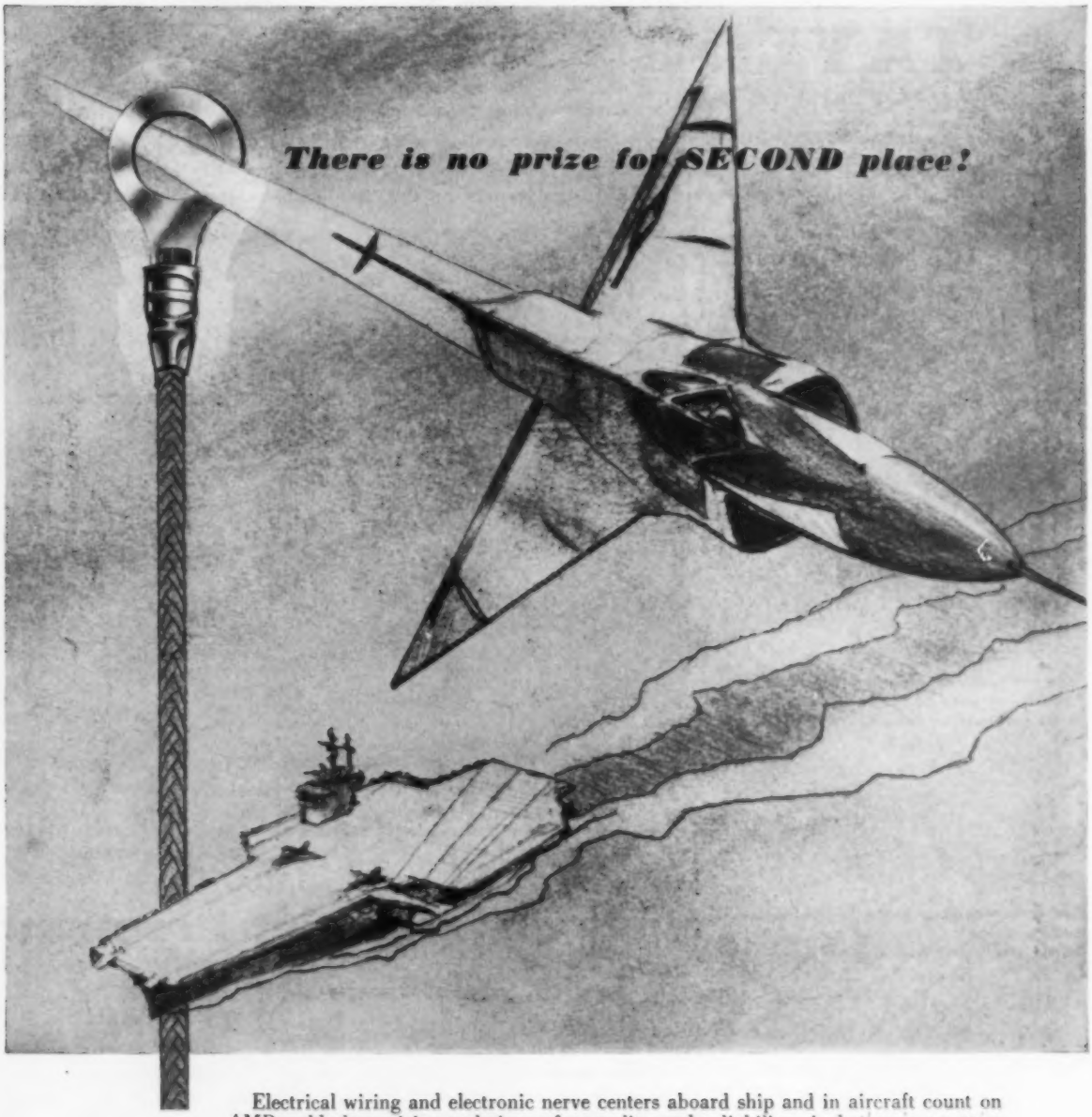
Carbon Is Versatile!

Can be:	Has:
Sawed	High corrosion resistance
Drilled	High heat transfer
Milled	Low electrical resistance
Broached	High thermal shock resistance
Turned	
Planed	High heat transfer (graphite)
Hobbed	
Ground	**Is:**
Molded	Non-warping
Extruded	Non wetted by molten metals
	Chemically inert
	Self-lubricating (graphite)

SPEER Carbon Co.

St. Marys, Pennsylvania

Divisions:
Speer Resistor • Jeffers Electronics
International Graphite & Electrode



Electrical wiring and electronic nerve centers aboard ship and in aircraft count on AMP solderless wiring techniques for quality and reliability. And, *there's no prize for second-best* . . . for vitally important to the successful performance of the circuitry within this equipment is the ability of its terminations to withstand critical requirements of vibration and resistance to corrosion.

The acceptability and reliability of A-MP products and techniques in the aircraft, appliance, automotive, electronics, power and transportation industries have been contributory factors to the success of AMP's shipboard wire terminating program and the safety, comfort and dependability of marine equipment.

Write today for AMP's new Marine Catalog, containing information about AMP's new shipboard wire termination program.

AMP INCORPORATED

GENERAL OFFICE: 5518 Eisenhower Boulevard, Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada. Aircraft-Marine Products (Great Britain) Ltd., London, England • Societe AMP de France, Le Pre St. Gervais, Seine, France • AMP—Holland N. V. 's-Hertogenbosch, Holland. Japanese Distributor: Oriental Terminal Products Co., Ltd., Tokyo, Japan.

TAYLOR
Laminated Plastics
Vulcanized Fibre

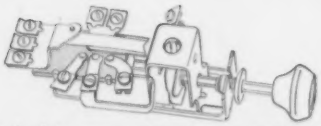
Shop Talk

TAYLOR FIBRE CO.

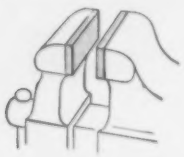
Plants in Norristown, Pa. and La Verne, Calif.

PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

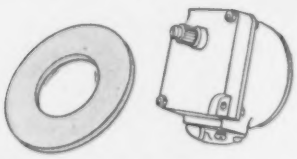
Tips for designers



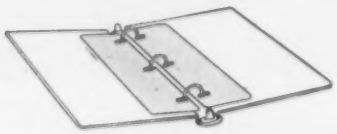
Back plate on an automobile headlight switch, punched and machined from Taylor Grade XP paper base laminate, has low moisture absorption and good dielectric strength.



Vise jaw caps, made of Taylor Grade C phenolic laminate, are easily cut and machined to shape. Marring of precision or delicate parts is eliminated.



Self-balancing servo motor has stator case insulator which is cold-punched from ¼" thick Taylor Paper Base Phenolic Laminate sheet.



Flippers for loose-leaf binders are made of economical Taylor Vulcanized Fibre . . . affording added rigidity and good protection for the paper pages.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.

Time switch, made by the Tork Clock Co., uses two Taylor products . . . the deadfront is made of vulcanized fibre for its insulating properties, shock protection and printability . . . the mounting panel of the clock is made of Taylor laminate XP-1-231, chosen for high strength and good punchability.

Have an Insulation Problem?

Taylor will provide the answer . . .

Select from Taylor's complete line of materials—laminates and vulcanized fibre—to get the right combination of electrical, physical and machining properties for your product. And, if you have a unique problem, Taylor will develop a special material to meet your requirements.

For example, rigid requirements for insulation materials in the Tork Clock Company's Time Switch were met by two Taylor materials—a laminate and vulcanized fibre. The mounting panel is made of Taylor laminate XP-1-231, especially formulated for the high strength and good punchability requirements of this application. In addition, Taylor vulcanized fibre serves as the deadfront—a shockproof cover removed only for installation and service. Fibre was chosen for its insulating properties, shock protection, and printability.

Taylor materials are developed to meet the need for dependable, moisture-resistant insulation. They have high dielectric and mechanical strength, and maintain original characteristics over long periods of time, under severe operating conditions. When you choose—and use—Taylor products, you'll have performance with stability.

Taylor application engineers can help you obtain the Taylor material that matches the exact requirements of your product. Contact your nearest Taylor sales office.

up and over

The Payoff Power *is Chrysler*

Huge, collapsible rubber containers for economically storing and shipping flowable bulk are *filled, transported, loaded* with speed and ease by one man and a 12-ton Silent Hoist *Lift-O-Krane*. This unique fork truck-crane combination is powered by Chrysler for maximum-load performance with minimum maintenance . . . equipped with Chrysler gýrol Fluid coupling for smoother starting and acceleration, longer engine life.

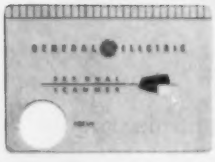
CHRYSLER INDUSTRIAL 33, in-line 6 Engine (265 cu. in. displacement) powers the Silent Hoist Lift-O-Krane—and many other makes of equipment in the construction and materials handling fields. There are five Chrysler in-line 6s, two V-8s—ranging from 230 to 354 cu. inch displacement. For detailed information about Chrysler Industrial Power, write: Dept. B-5, Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.

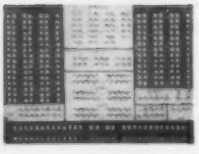
Chrysler

INDUSTRIAL ENGINES

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

CUT ENGINEERING COSTS WITH U. S. RADIUM DIALS PANELS NAMEPLATES





Cutting your engineering costs is routine for U. S. RADIUM CORPORATION. As the only company in its field to provide all standard techniques for marking data display parts, USR is in position to recommend the most economical method or combination of methods for fabricating instrument dials, control panels and original equipment nameplates to your requirements.

UNITED STATES RADIUM CORPORATION currently offers both the light transmitting plastics and metals such as aluminum, brass, stainless steel and nickel silver as stock blanking materials. A wide range of colored or luminous durable finishes may be applied to these materials by any of the following processes:

- Screening
- Photo-reproduction in LACKON® finishes
- Mechanical engraving
- 1-up offset
- Etching
- Lithography

Each of these processes exhibits its own characteristic advantages in durability, processing speed, flexibility, economy, accuracy and appearance. To expedite handling of your orders, the engineering and development facilities of U. S. RADIUM are at your disposal. Your inquiries are invited. Write Department P-5.

US RADIUM

UNITED STATES RADIUM CORPORATION
Morristown, New Jersey

5942 W. Chicago Ave., Chicago 51, Illinois
5420 Vineland Ave., North Hollywood, California

Affiliates
CANADA: Radelin-Kirk Ltd., 1168 Bay St., Toronto, Ont.
EUROPE: United States Radium Corporation (Europe) 36 Avenue Krieg, Geneva, Switzerland.

of many years of extensive research. However, a clear understanding of the brittle fracture mechanism still is unavailable and is needed for the eventual development of satisfactory design procedures.

This paper describes a fundamental investigation in brittle fracture in large steel plates. The plates are tested under various conditions of stress and temperature with a brittle fracture initiated at an edge notch by a wedge subjected to impact. Instruments are applied to the specimens to provide a record of strain response and crack speed as the brittle fracture crosses the specimen.

Fracture initiation studies and instrumentation are described primarily for the benefit of other investigators. Striking tests, made on several specimens which did not fracture, indicate that small strain changes were produced by the notch-wedge-impact method of fracture initiation. A typical test record from both a 2 and 6-ft wide plate is presented to illustrate the type of data obtained from these tests. General observations relating to strain response, crack speed and fracture appearance are presented.

Abstracted from, "Brittle Fracture Propagation In Wide Steel Plates," by W. J. Hall, R. J. Mosborg and V. J. McDonald, University of Illinois, Urbana, Ill., Welding Journal, Jan. 1957.

Motivation of Engineering Students in the Study of English

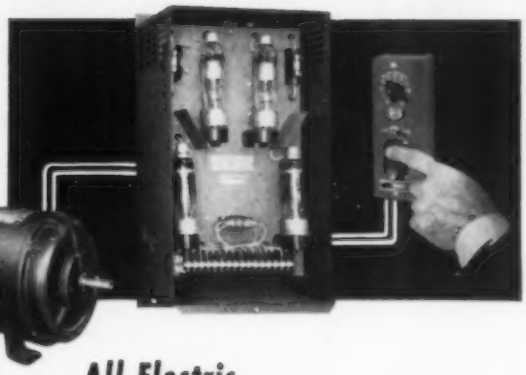
Employers of engineering graduates appear almost unanimously to believe that these young people do not know how to speak or to write effectively. There also appears to be a reasonably large group of people who think engineers are uncouth individuals who consider "culture" and "gadgets" to be synonymous.

Most engineering freshmen think that a good engineer is a man who can solve many differential equations and then construct devices that are useful analogs of the equations; they expect to learn such things in college. Accordingly, the freshman is strongly motivated to study mathematics, and even physics and chemistry, with some enthusiasm. When he is faced simultaneously with a course in composition

(continued on page 428)

New!

RELIANCE V*S Jr.



All Electric
Variable Speed Drive
with Finger-tip Control

The new V*S Jr. gives you instantaneous speed changes, even under load, without belts, pulleys, or gears. This Reliance Drive puts complete machine control at the operator's fingertips. All functions, jog, start, stop, reverse and speed changes are placed in a compact, remote control station.

The 8 to 1 motor speed ratio puts extra flexibility into your machinery. Speeds may be changed through this wide range as frequently as required. The motor will operate through a 100 to 1 speed range for jogging or light intermittent duty.

There's a big power cushion in the motor too . . . power for smooth speed pick up, even under heavy shock loads, and dynamic braking for fast controlled stops without shuddering or jerking.

The Reliance V*S Jr. is your answer to machinery drive problems in the ¾ to 4 horsepower range. Package construction makes installation easy; just plug it in to a single phase 220 or 440 volt a-c. line.

Write for Bulletin D-2505 for complete details. D-1554

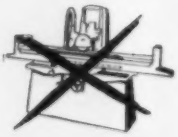
RELIANCE ELECTRIC
AND ENGINEERING COMPANY
DEPT. 305A, CLEVELAND 17, OHIO
CANADIAN DIVISION: WELLAND, ONTARIO
Sales Offices and Distributors in principal cities

NO, NO... a thousand times "NO"

"NO loss of time," say the thousands of users of LAMINUM SHIMS...

NO machining!

NO grinding!



NO counting!

NO stacking!

NO miking!

LAMINATED SHIMS OF

LAMINUM

SURFACE BONDED... THEY peel FOR ADJUSTMENT

Laminated Shims of LAMINUM now available in

STAINLESS STEEL with laminations of .002" or .003"	ALUMINUM with laminations of .003" only
BRASS with laminations of .002" or .003"	LOW CARBON STEEL with laminations of .002" or .003"

LAMINATED SHIM COMPANY, INC.

Shim Headquarters since 1913

1405 Union Street, Glenbrook, Conn.

and speech, or literature, or history, however, he is likely to resent the intrusion on the time he wants to devote to mathematics or physics.

Such young men and women often lack any appreciation of the vast areas of man's knowledge that involve ideas, which cannot be expressed quantitatively. These include the subjects of philosophy, history, literature and art in other forms, and many areas in the social sciences. Engineering educators recognize this difficulty. They continually seek methods which will impress upon the student the importance of these areas in the education of the whole man.

There is a conviction that a truly professional engineer is a man who, by his ability for thought and action, can solve new problems which are based in science, but which have components dealing with people and their interactions. As soon as one is convinced that this is so, education in the humanities and social sciences becomes a practical problem.

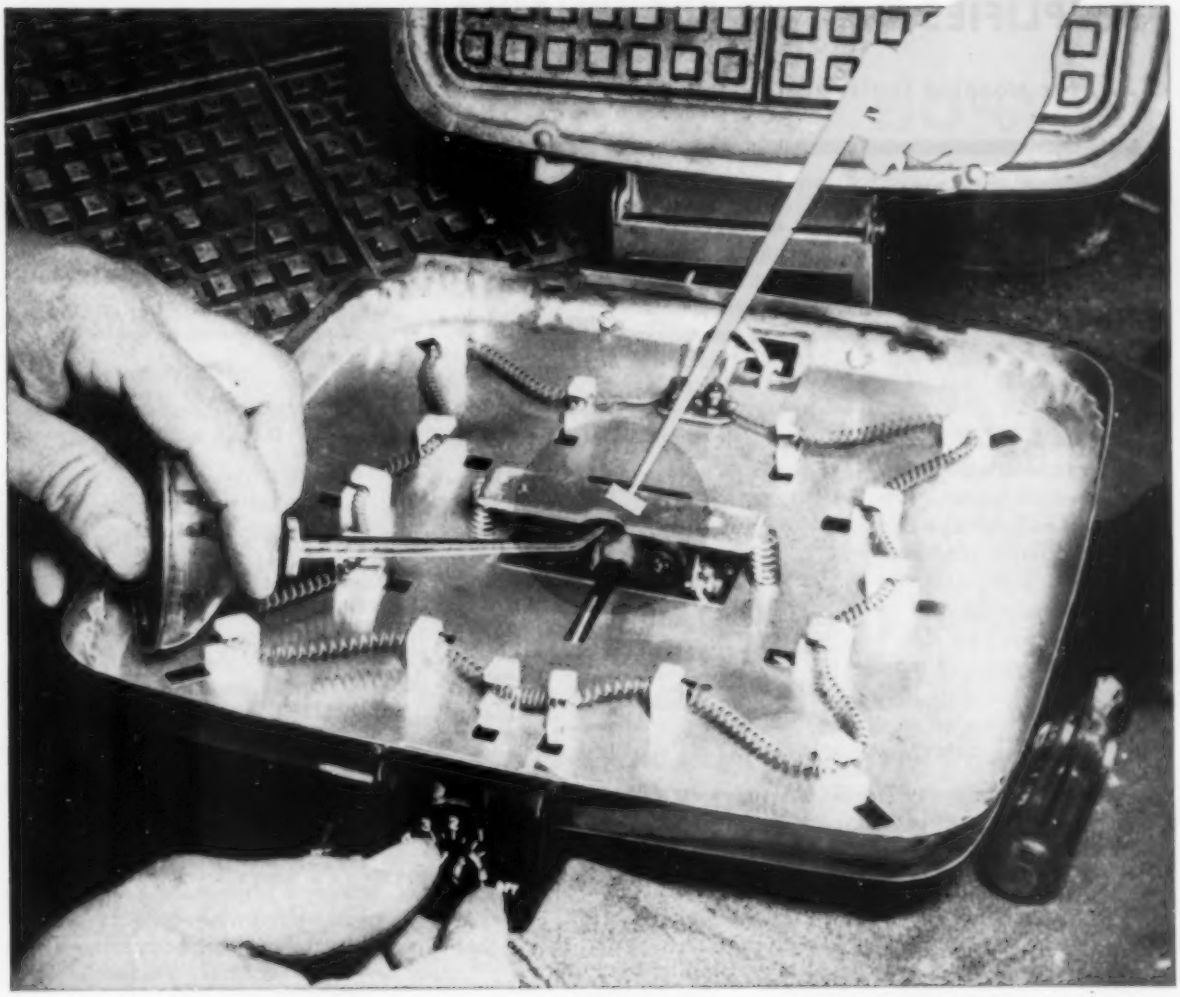
At this point it is easy to make a mistake. There is an implication in the last paragraph that what is needed is a series of training courses that will tell the engineering student just what he needs to know about psychology, sociology, economics, literature, art. This is of course a subversive idea. Each individual needs to be stimulated to develop himself.

Present courses in the humanities are very likely to be inappropriate for any student except one who wishes to major in a particular field of which such course is a part. There have been some interesting attempts at solutions to this problem. For example, the economists have devised fundamental courses at a reasonably high scholarly level which combine a discussion of principles and a description of some applications of principles. It turns out that such a course may be simultaneously satisfactory for a student of economics, an engineering student, or a student of the liberal arts who wishes to elect a course in economics. This appears to be a very fruitful line of endeavor.

Another course with comparable aims, entitled "Collateral Reading," was introduced by Harold Pender in 1926 and continues in a somewhat different form to the present day. The

(Continued on page 430)

A Touch here does so much



RED HOT CELL MATE . . . FOR LIFE

A touch of 'dag'® Colloidal Graphite gives lifetime lubrication to parts operating next to red-hot elements in pop-up toasters and other appliances. It does the same for planetary gears exposed to 1500°F. in high-intensity searchlights.

Where life performance must be built into inaccessible mechanisms, 'dag' dispersions form thin, protective films capable of withstanding temperature extremes and other severe conditions. Your Acheson Service Engineer can discuss the application of 'dag' dispersions related to the life performance of your design. Talk with him soon, and write for Bulletin 423 containing information on design applications for 'dag' dispersions. Address Dept. **PE-5.**

dag®

ACHESON COLLOIDS COMPANY

Port Huron, Michigan . . . also Acheson Colloids, Ltd., London, England

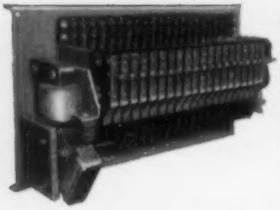
ACHESON COLLOIDAL DISPERSIONS:

Graphite · Molybdenum Disulfide · Zinc Oxide · Mica and other solids

Offices in: Boston · Chicago · Cleveland · Dayton · Detroit · Los Angeles
Milwaukee · Philadelphia · New York · Pittsburgh · Rochester · St. Louis · Toronto

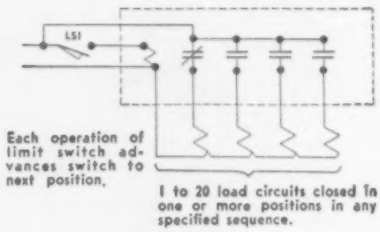
NEW EAGLE STEP SWITCH SIMPLIFIES CIRCUIT SEQUENCING

. . . for machine tools, presses, conveyors, processes

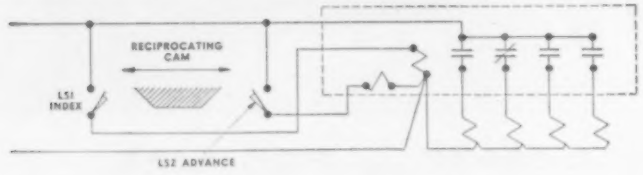


These 3 basic ideas are yours for simplified interlocking or sequencing of multiple load circuits. Any and all three will eliminate many other electrical components, and cut your initial cost.

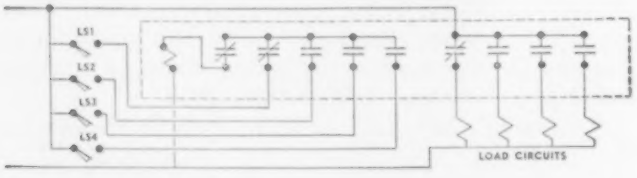
Operating load circuits in sequence: A limit switch on a machine or indexing device closes and opens upon each operation to advance the Eagle step switch. Or a timer may be used to operate each load circuit for a predetermined time.


LS1
Each operation of limit switch advances switch to next position.
1 to 20 load circuits closed in one or more positions in any specified sequence.

Interlock sequence: *Two limit switches* are operated alternately. This provides a safety feature. It insures that the movement of the machine has been completed before the Eagle step switch advances.



Interlock sequence with several limit switches: Each limit switch advances the Eagle step switch one position. Switches must operate in sequence or the step switch won't advance.



Send for new Eagle Bulletin 850. Simply write to Eagle Signal Corporation, Industrial Timers Division, Moline, Illinois, Dept. PE-557.

course, or sequence of courses, has been presented to sophomores, juniors, and seniors; and sometimes for as many as four terms, for the regular students of the electrical engineering curriculum.

This course illustrates a general principle: It is entirely practicable for the staff of an engineering school to contribute to the development in each student of an interest in humanities.

Abstracted from, "The Motivation of Engineering Students in the Study of English," by S. Reid Warren, Jr., University of Pennsylvania, Phila. 4, Pa., Journal of Engineering Education, Nov. 1956.

Steel Band Conveyor On V-Belts

A Swedish firm has just made available a conveyor composed of an endless steel band bonded to a series of v-belts. The conveyor is driven by grooved pulleys spaced to engage the v-belts.

The v-belts are vulcanized onto the surface of the steel band, the bond resisting temperatures between —30F and 212 F.

Advantages of the new conveyor are straight travel and low maintenance. Straight motion of the conveyor belt also cuts down space requirements.

One characteristic of the new conveyor is the low slippage between belt and driving pulleys, especially desirable in atmospheres having a high fat content, as in the processing of margarine.

Abstracted from "Kilrepsstyrda stalbandstransportorer," Affarsekonomi (Sweden), No. 7, 1956.

Professors vs. Engineering Education

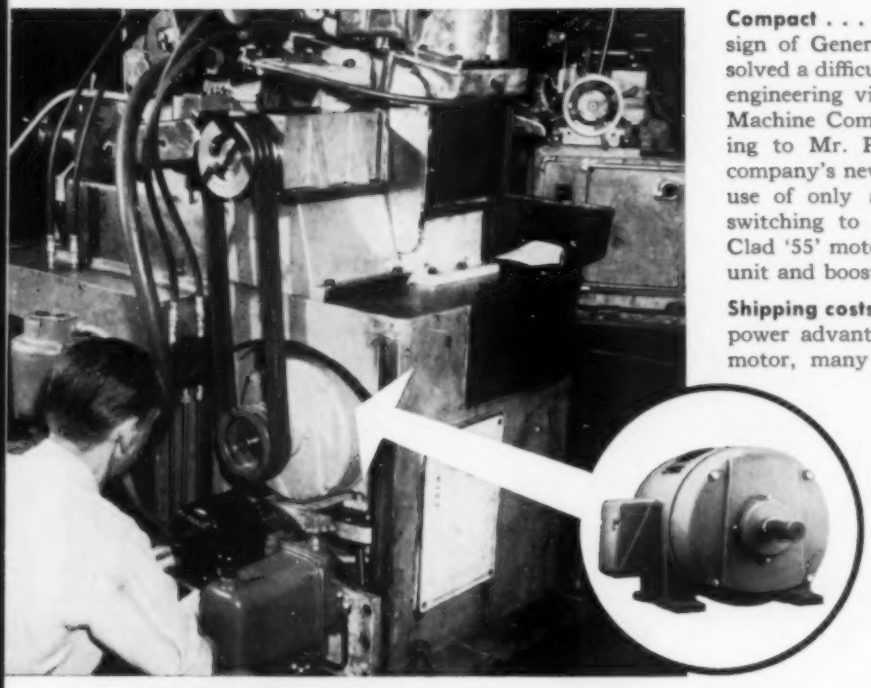
In recent years, we have heard that institutes of higher learning are faced with a shortage of professors. It seems to me that there is, already, an adequate supply of professors but we do need teachers.

Many of us are often very discouraged by the attitudes of the young graduates we interview. Many of those attitudes, I believe, begin in college and are inherited from some of the professors.

New graduates appear to be inter-

(Continued on page 434)

"We switched to the compact G-E TRI 55 CLAD motor and boosted power by 50%"



Compact . . . power-packed—The compact design of General Electric's Tri-Clad '55' motor solved a difficult power problem for Roger Pyne, engineering vice-president of the Van Norman Machine Company, Springfield, Mass. According to Mr. Pyne, "space limitations on the company's new centerless grinder permitted the use of only a 5-hp conventional motor. By switching to the smaller, more compact Tri-Clad '55' motor we were able to go to a 7½-hp unit and boost our grinder's capacity by 50%."

Shipping costs reduced 40%—In addition to the power advantages of the smaller Tri-Clad '55' motor, many companies are finding that the lighter, easier-to-handle motor has cut shipping and handling costs as much as 40%. Contact your nearest General Electric Apparatus Sales Office to learn the many years-ahead benefits that the new Tri-Clad '55' motor can bring to your product . . . to your operation.

FREE SLIDE RULE

ADVANCE INFORMATION TO HELP YOU PLAN AHEAD

WRITE FOR FREE SLIDE RULE which lets you determine at a glance the weight and space benefits of recently announced NEMA standards for larger motors. This handy slide rule provides advance information to solve your design problems . . . to benefit your overall operation.

SECTION B891-1
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, NEW YORK

I want advance information on new NEMA dimensions for larger motors. Please send me free slide rule.

NAME _____

COMPANY _____

ADDRESS _____

CITY & STATE _____

TITLE _____

Progress Is Our Most Important Product

GENERAL ELECTRIC

FLEXIBLE SHAFTING

ENABLES YOU TO TRANSFER POWER OVER, UNDER, AND AROUND OBSTACLES ECONOMICALLY AND EFFICIENTLY

Circle Ess Flexible Shafts offer economical construction and low maintenance costs for remote control applications. Many manufacturers reduced expenditures, and saved space by using flexible shafting to eliminate alignment problems and ALL gearing. For complete information about Circle Ess Flexible Shaft assemblies and our Adapters used with Flexible Shafts write to us on your letterhead.

.150" O.D. CABLE
Steel Cable—Minimum Operating Radius 4" — Torsional Strength 13 Lb.".

.312" O.D. CABLE
Steel Cable—Minimum Operating Radius 5" — Torsional Strength 125 Lb.".

CASING
Single Wire, Burnished Cotton Braiding, Light Weight and Very Flexible.

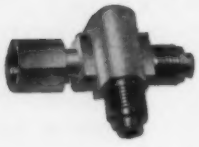
CASING
2 or 4 Wire, Synthetic Rubber Cover, Water Proof and Non-Abrasive.

TYPICAL ASSEMBLY
Combination Cable, Casing, and End Fittings For Specific Application.

TYPICAL ASSEMBLY
Combination Cable, Casing, and End Fittings Provides Higher Flexibility.

H TYPE ADAPTER
This adapter provides three outlets, which enables the running of three units from the same power source. Ball bearing construction enables this adapter to handle heavy loads.

RIGHT ANGLE ADAPTER
To provide a connection for flexible shaft control where space limitations do not permit a conjunction without bending the shaft into too small a radius.



DUAL DRIVE ADAPTER
To drive more than one unit from the same power source and to provide two gear ratios from the same power source.

BALL BEARING RIGHT ANGLE ADAPTER
To provide a connection for flexible shaft control where a bend sharp enough to damage the shaft is required. Ball bearing construction enables the handling of heavier loads.

Ask for Bulletin 400D

.187" O.D. CABLE
Steel Cable—Minimum Operating Radius 4" — Torsional Strength 25 Lb.".

.250" O.D. CABLE
Steel Cable—Minimum Operating Radius 6" — Torsional Strength 65 Lb.".

CASING
2 or 4 Wire, Wire Braiding, Attractive Plastic Covering, Resists Grease.

CASING
Non-Magnetic Square Locked, Copper and Aluminum Braiding, Aluminum Covered.

TYPICAL ASSEMBLY
Combination Cable, Casing, and Flat End Fittings For Specific Application.

TYPICAL ASSEMBLY
Combination Cable, Casing, and Bell Type Ferrule For Various Applications.

F.W. STEWART CORP.

4311-13 RAVENSWOOD AVENUE · CHICAGO 13, ILL.

WEST COAST PLANT: 1638 So. Flower Street, LOS ANGELES 15, CALIFORNIA.

CIRCLE ESS

...for greater dependability...LONGER

LINEAR KEEPS THE "BITE" IN A BACK-HOE
with Roto-Mold "O" Rings

The "bite" of a back-hoe—or any of the countless other small and large earth moving machines—depends on the use of precision seals that can retain hydraulic pressure in pumps, controls and actuating cylinders under all conditions. LINEAR Precision Roto-Mold "O" Rings provide the dependability that keeps expensive equipment operating longer at peak efficiencies—around the clock.

LINEAR'S extensive experience in working with all types of elastomers enables the selection of materials that can stand up under extreme temperature variations, continuous exposure to abrasive dirt and dust, and against surge pressures which may fluctuate to as much as 50,000 psi.

The exclusive Roto-Mold process makes possible precision "O" rings—physically better—free from foreign inclusions and flash. Another plus is scheduled deliveries at maximum economy.

No matter what your sealing problem may be—call on LINEAR or one of its agents for engineering assistance—and be sure to specify LINEAR Roto-Mold "O" Rings.

"PERFECTION IN RUBBER"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

...design engineers

at the design engineering show bring your gear design problems TO THE "GEAR DESIGN CLINIC"

under the direction of

T. W. KHIRALLA
Vice-President — Engineering and Research,
Geartronics Corporation

PROF. EARLE BUCKINGHAM
Technical Director,
Geartronics Corporation
1957 ASTE Gold Medal Recipient for work "as a world authority upon gear design and application"

Tickets available at Booth 826

Geartronics Corporation gear design engineers will be available to answer your gear design questions at Booth 826 during the entire 4 days of the show.

Geartronics CORPORATION

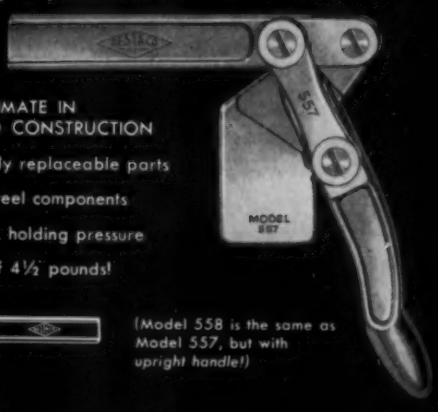
50 NASHUA STREET
WOBURN,
MASSACHUSETTS

DIVISIONS | GEAR SYSTEMS INC., WEST CONCORD, MASS.
MASSACHUSETTS GEAR & TOOL CO., WOBURN, MASS.

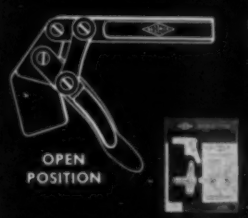
announcing 2 NEW

DE-STA-CO TITAN TOGGLE CLAMPS!

(Models 557 and 558)



- THE ULTIMATE IN RUGGED CONSTRUCTION
- completely replaceable parts
- forged steel components
- 4,000-lb. holding pressure
- weight of 4½ pounds!



OPEN POSITION

(Model 558 is the same as Model 557, but with *upright handle!*)

Send for **FREE Literature** on these new DE-STA-CO Titans—Models 557, 558!

DE-STA-CO DETROIT STAMPING COMPANY

WORLD'S FIRST LINE OF TOGGLE CLAMPS

320 Midland Avenue • Detroit 3, Michigan

ested only in how much they can gouge out of industry due to the shortage of engineers. Little thought is given to the creative nature of the work or what it means to society, or even what it means to the individual himself.

During the course of "teaching," how many professors take time to make the technical fields seem appealing or challenging, or, yes, even enjoyable. Can it be that the professor himself believes that only technical facts and salary are involved, but no personal feeling?

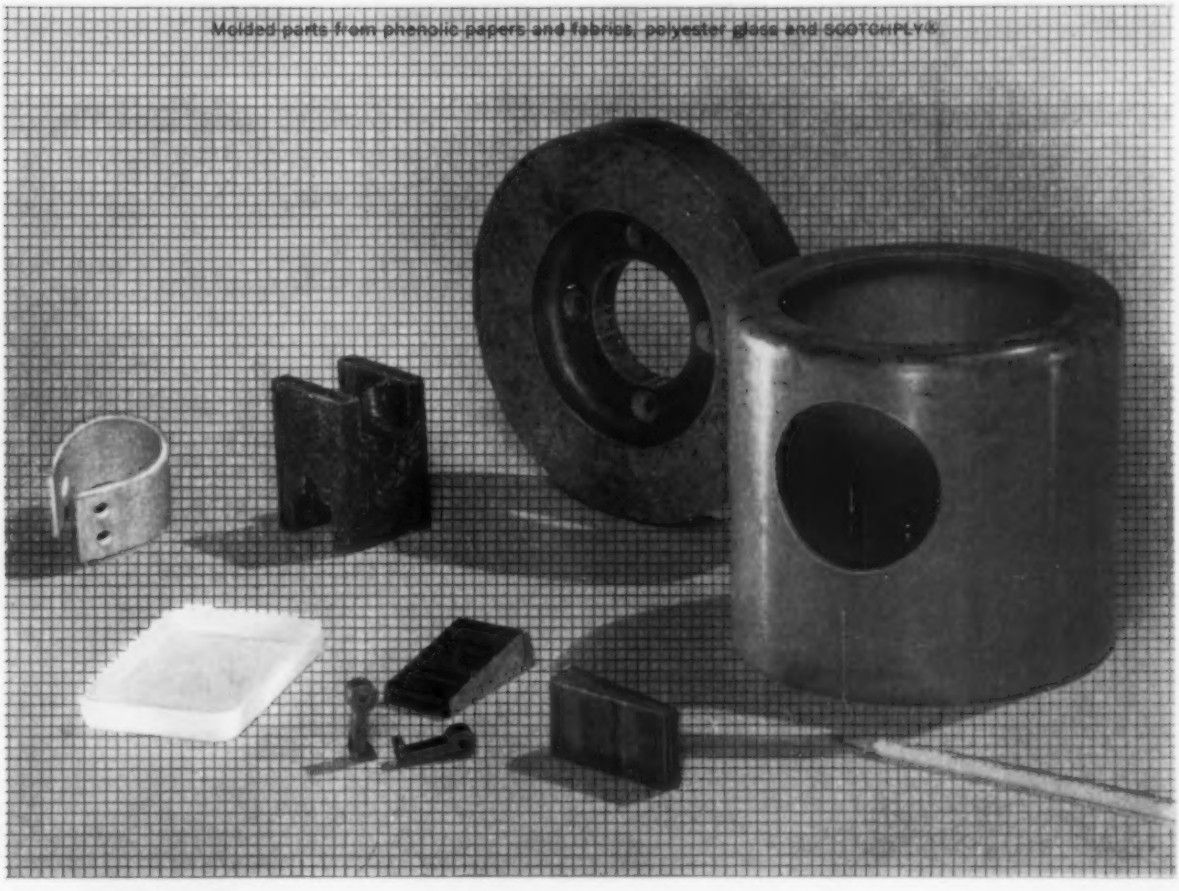
The student is given little orientation in regard to what he can expect in the shop, so how can you expect him to fit into the industrial picture where the atmosphere and personnel are entirely different from scholastic circles? How many professors really know anything about industry except for a few "field trips" they take with the boys? If he doesn't know it, why not occasionally bring in an outstanding man from the industrial field to cover those points?

One of the greatest deficiencies I find in young engineers is their almost complete lack of curiosity. What do the professors do to stimualte the curiosity of their students? Certainly this can't be done by textbook reading and mass techniques of teaching. I believe some professors use the teaching profession to escape from the impact of ideas outside their ivory tower. They are simply not stimulating persons themselves and they certainly don't stimulate the students.

Many engineers are eager to climb the ladder in industry as rapidly as possible. Then suddenly they find themselves in a high position, but frustrated beyond belief. They wonder what ails them and sometimes develop a very sour outlook on life in general. Shouldn't the professors teach them in schools that climbing up the latter of success in industry is accompanied by added stress and strain, and paid for by sacrifice of more and more of self? Big money isn't paid just out of goodness of heart. You have to earn it in some way.

Temperament, constitution are often far bigger factors than intelligence or ability. By the time they graduate, students should know this and have some idea of their own limitations

(Continued on page 438)



For better molded laminates...
LET MICA MOLD IT

MICA'S *greater knowledge of materials, molding know-how, ability to vary materials as required, and problem-solving abilities pay off.*

For savings, let MICA mold it. Our knowledge of base materials and molding methods, our undivided responsibility for quality of both materials and workmanship, and our specialized equipment save time and assure consistency, accuracy and prompt delivery.

For special applications, let MICA mold it. Our molding materials include LAMICOID® phenolic papers and fabrics, polyester glass and SCOTCHPLY® epoxy glass. These materials offer light weight, high strength and stability, chemical resistance, insulating properties, heat resistance and low moisture absorption. This wide range of properties meets many different application requirements.

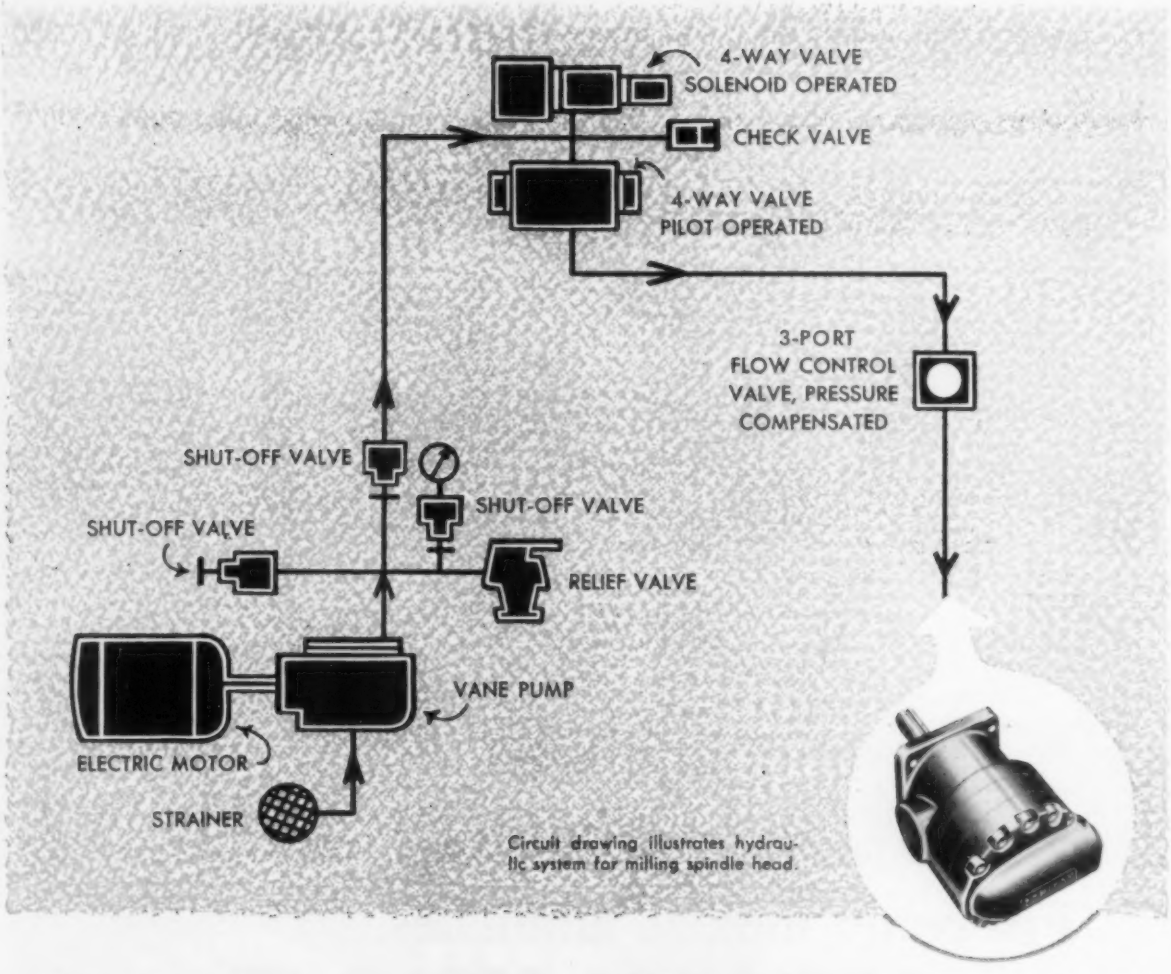
For special processing, let MICA mold it. We are fully equipped to mold parts of intricate shape or difficult contours by matched metal die compression molding. Our facilities include complete fabricating equipment for further machining and finishing of molded parts.

For creative engineering, let MICA mold it. We are prepared to apply our knowledge of base materials, molding and fabricating methods, and application experience to the design and manufacture of prototype or experimental materials and parts.

For prompt quotation on your needs, send us your prints and specifications. We can also supply machined parts from paper, linen, canvas, nylon, asbestos and fibrous glass base materials. A MICA representative will be happy to give you any engineering assistance needed.

SCOTCHPLY® is a registered trademark of Minnesota Mining and Manufacturing Co.

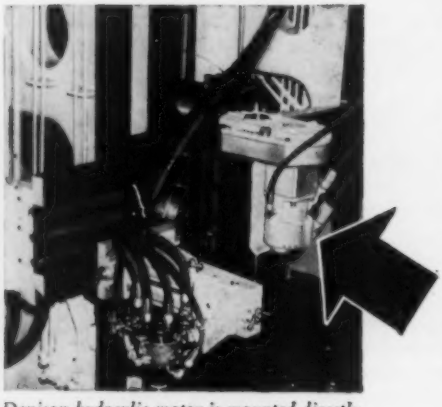
MICA INSULATOR COMPANY
761 Broadway, Schenectady 1, New York
A Subsidiary of Minnesota Mining and Manufacturing Company



Circuit drawing illustrates hydraulic system for milling spindle head.

Developing a compact, efficient spindle head

...another application for Denison hydraulic power



Denison hydraulic motor is mounted directly to gear case of spindle and powers driver gear of the gear train.

THE PROBLEM: to develop a compact, efficient milling spindle head with infinitely variable spindle speed and instantaneous speed selection.

For True-Trace Sales Corporation of El Monte, California, the solution involved the use of hydraulic power...and Denison hydraulic equipment.

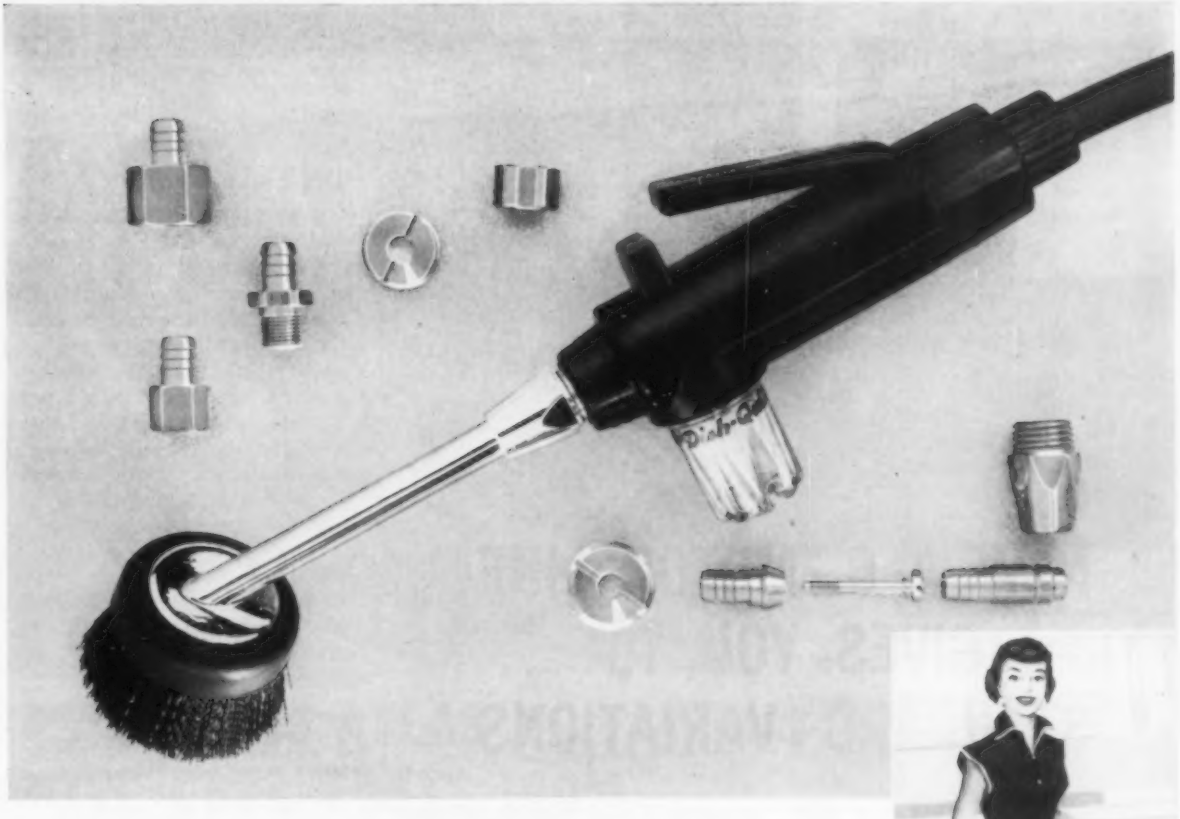
The result was spindle with a 15 hp rating and speeds up to 3000 RPM. To drive the spindle, True-Trace selected a Denison TMC-3 fluid motor. Variable speed control is achieved with a Denison 3-port flow control valve. The control's nine separate ranges permit exact speed selection by the operator.

Let a Denison hydraulic specialist help you with your design problems. Write Denison Engineering Division, American Brake Shoe Co., 1194 Dublin Road, Columbus 16, Ohio.

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

DENISON Hydraulics

Why *Dish-Quik*® uses Chase Free-Cutting Brass Rod!



"No other metal combines such production speed with quality results!"

HAROLD E. CONNELLY, *Purchasing Agent, Modern Faucet Mfg. Co.*

Housewives want economy and long-lasting dependability from their appliances — and the makers of Dish-Quik know it! That's why this beautifully-designed, labor-saving faucet attachment was fabricated from so much free-cutting Chase brass rod!

For one thing, using Chase free-cutting brass rod assures Modern Faucet Mfg. Co. of highest production speed and top-quality work. What's more, parts made from this tough, corrosion-resistant rod won't clog with rust from their daily contact with hot and cold water. They shrug off hard knocks that are part of frequent use.

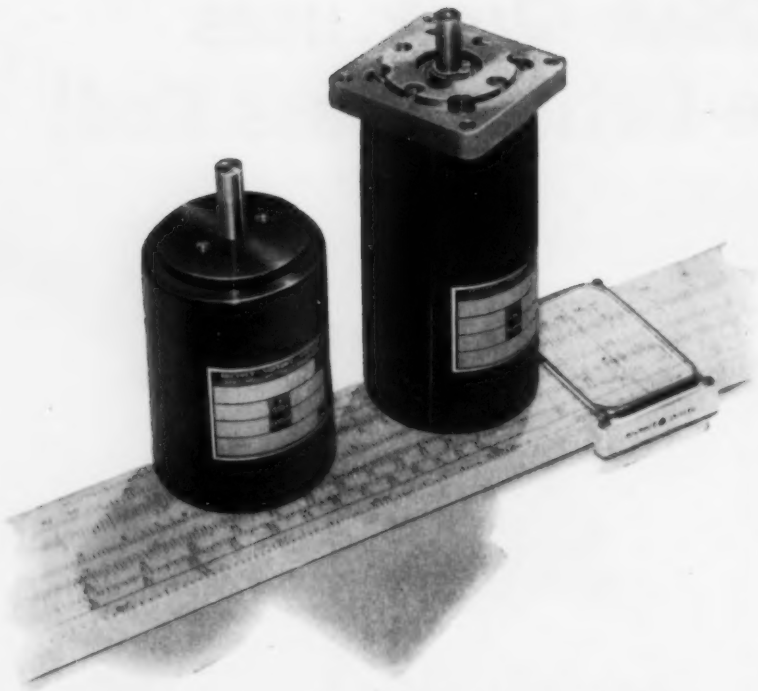
The end result? A de-luxe product made to give more *value* to consumers — at the lowest *cost* to the manufacturer!

Bring your production problems to...

Chase®
BRASS & COPPER CO.
WATERBURY 20, CONNECTICUT
SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York (Maspeth, L. I.) Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury



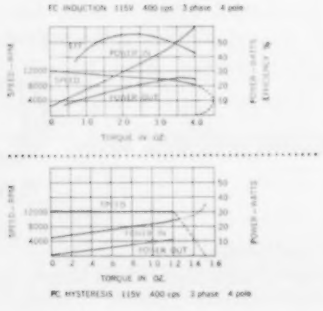
NEW A. C. MOTOR LINE GIVES YOU 10^5 STANDARD VARIATIONS

From Globe you can get fast delivery of complete miniature power systems designed around new FC motors—115 or 200 V.A.C., 60 or 400 cycles—induction, hysteresis, or dual speed rotors, wound 3 phase, 2 pole or 4 pole; 2 phase, 2 pole or 6 pole; single phase with a matched capacitor. Units are designed to meet MIL specs; operating characteristics and configuration can be modified.

Package can include integral gearing, either planetary or spur. Choose from 102 standard ratios from 4:1 to 3,000,000:1. Choose from 408 standard speeds. Gear units range in length from 1.043" to 1.953". WRITE FOR FC BULLETINS.

Globe's small AC motor packages are built around units 1.07" dia., 1.25" dia., and the newest 1.675" dia. x 2.250" long. Standard modifications in type, winding, gearing, and performance offer you millions of combinations at reasonable cost. Globe also makes D.C. governed and gear reduced motors, servo motors, actuators, timers, generators, gyros, blowers, fans, and control systems.

GLOBE INDUSTRIES, INC.
Dayton 4, Ohio



in this respect. Are they being educated concerning these things? If they were they might establish more realistic goals for themselves and, thus, contribute more to their profession.

Abstracted from, "Professors vs. Engineering Education," by Hiram Brown, Chief Metallurgist, Solar Aircraft Co., Des Moines, Iowa, Journal of Engineering Education, Nov. 1956.

Glass Flake Laminate

Interest in preparation of glass-reinforced laminate with glass reinforcement in the form of flakes rather than fibers was based on expected plane rather than line-type properties, with resulting increase in effective strength-to-weight ratio. Additional advantages expected are: increased bond area between resin and glass, thinner and stronger adhesive bonds, increased stiffness of the laminate, low cost and high productivity, and higher resistance to penetration by moisture, chemicals, sunlight or ballistic particles.

Glass content could be easily increased to 80 or 90% by weight, with proportionate increase in the properties of the laminate.

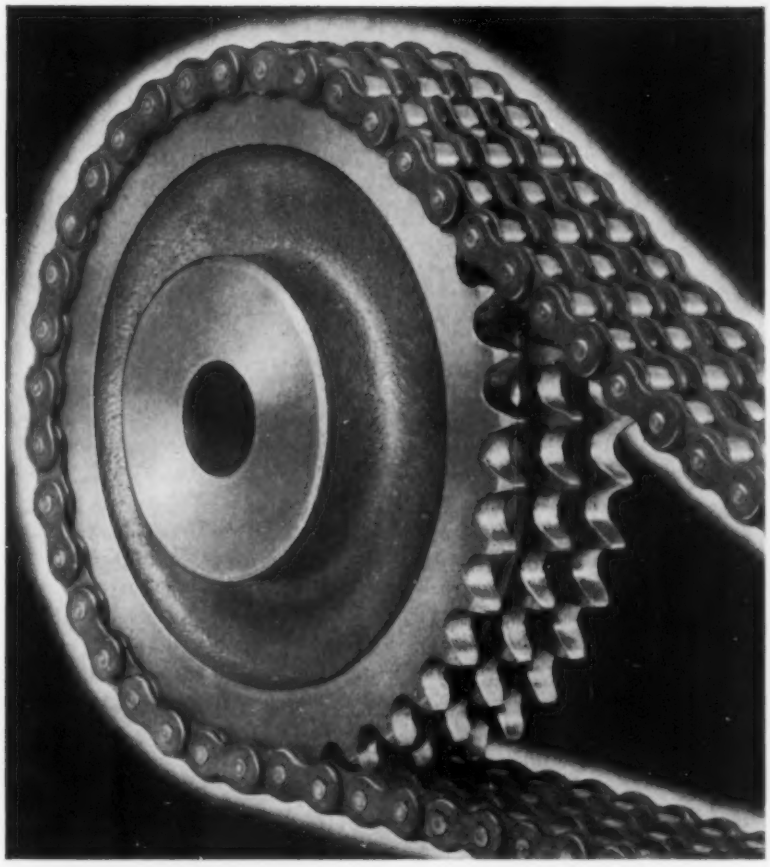
Abstracted from "Glass Flake Laminate," by George Rugger, Plastic Research Section, Picatinny Arsenal, SPE Technical Papers, presented at the Thirteenth Annual National Technical Conference.

Human Factors in the Management of Engineers

An engineer often is promoted to a management or supervisory position without being helped to discover that this responsibility must be separate and distinct from his engineering activity, and that it must be predominant. Too often a manager becomes engrossed in the mechanics of management—of creating and controlling a structure—and neglects the dynamics of management—inspiring and energizing the persons who are in his domain. Indeed, it is only these who can or will produce. Organization structure is nothing more than a means to the end of greater effectiveness and more productivity.

Too often we think of an engineer as a member of a group, often a large group, rather than an individual

(Continued on page 442)



ATLAS *Electrolized* ROLLER CHAIN

Available in all sizes for tiny timers to big, tough multiple chain drives. Regular or heavy duty . . . standard or extended pitch . . . steel, stainless steel, bronze or the new exclusive Atlas Electrolized Chain.

ATLAS *Balanced* SPROCKETS

Precision made to exact chain fit. Available in all sizes 3/8" pitch to 2" pitch . . . steel, stainless steel, bronze or Atlas Electrolized for longer life.

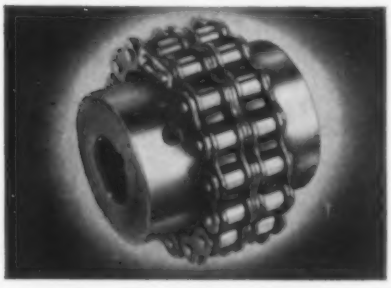
TESTS PROVE ATLAS *Electrolized* DRIVE CUTS COSTS 100%

LESS FRICTION . . . HIGHER TENSILE . . . CORROSION RESISTANT

Out of the modern laboratories of Atlas come results on grueling torture-tests of Atlas Electrolized Roller Chain. Proof that when used on power drives it outlasts others by as much as 100% . . . possesses a higher tensile strength than other corrosion resistant chain . . . has a lower coefficient of friction to reduce power losses.

Atlas Roller Chain, Sprockets and Flexible Couplings are precision matched to operate as a power team for peak efficiency. They are made to run quieter, last longer and require less maintenance. They are a *power team* to provide higher efficiency and longer life on every type of installation.

ATLAS CHAIN AND MANUFACTURING CO., P.O. Box 708, West Pittston, Penna.



ATLAS FLEXIBLE COUPLINGS

Quiet running, ruggedly built for every drive. Available from stock—bore 7/16" to 3 15/16" . . . O.D. up to 7 15/16".

GET THE FACTS

Please send data on how to increase efficiency with

POWER SAVING TEAM

TITLE _____

NAME _____

COMPANY _____

ADDRESS _____ STATE _____

CITY _____

ATLAS

POWER TRANSMISSION PRODUCTS

This composite picture represents 100 Richardson tool and die men with a combined experience of 12 centuries.

. . . . better molded parts because of

1200 years of tool and die experience

At least 50% of getting a good molded part depends on the quality of your mold.

The composite photo shown to the left represents the broad and varied experience needed for the design and production of quality molds to close tolerances . . . it represents 100 Richardson men with more than 1200 years combined experience in the design and production of tools and dies for the production of molded plastic parts.

The men who make Richardson molds know and respect the many "ifs" encountered in the design and production of quality molds. They know that . . .

. . . if your mold isn't correctly designed, the resulting parts will not be according to specifications.

. . . if your mold is not properly designed, the parts cannot be ejected quickly, production speed will be reduced, and unit cost increased.

The Richardson mold and die shop at Melrose Park, Illinois, is one of the largest in the plastics industry.

. . . if your mold walls are not of uniform thickness, curing time is increased.

. . . if your mold is not properly designed, resulting excessive flash must be removed by hand . . . a costly procedure.

Richardson engineers can assist your engineers in (1) redesigning parts for conversion from other materials to molded plastics, and (2) designing to improve molded parts now in production.

For additional information and a copy of the newly published catalog, "Richardson Molded Plastics," write or phone, today . . . Chicago number, MAnsfield 6-8900.

The RICHARDSON COMPANY

MOLDED AND LAMINATED PLASTICS

. . . better plastics for better parts

Dept. 17, 2793 Lake St., Melrose Park, Illinois

NEW...

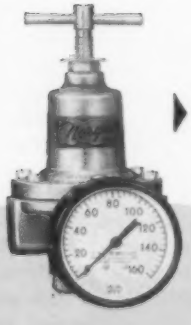
Norgren

PRESSURE REGULATORS

FOR AIR, WATER, OIL,
NON-CORROSIVE LIQUIDS
AND GASES

GREATER ACCURACY
BETTER PERFORMANCE

- **IMPROVED ACCURACY OVER A WIDER OPERATING RANGE**
- **GREATER ACCURACY OF REGULATED PRESSURE** even with widely fluctuating line pressure and rapidly varying flow.
- **LARGER FLOW CAPACITY**
  - a. Balanced Valve Construction
  - b. Greater Effective Diaphragm Area
  - c. Improved Baffle and Siphon Performance
  - d. Larger Passages
  - e. Larger Valve Openings
- **RELIEVING AND NON-RELIEVING TYPES AVAILABLE FOR AIR**



For complete information on all your regulator needs, ⅛" to 2" inclusive, call your nearby Norgren Representative listed in your telephone directory — or WRITE FACTORY FOR LITERATURE.

C. A. NORGREN CO.

3428 SO. ELATI STREET • • • ENGLEWOOD, COLORADO

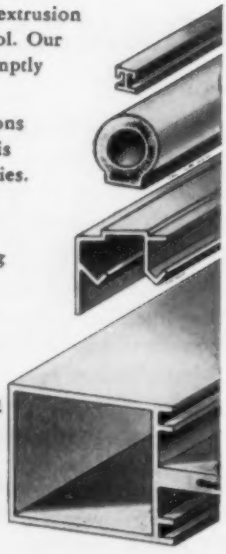
This PE extrusion made with a triple port, 4 mandrel die. Quality control assured because dies and extrusions produced in our own shop.

You are assured — a highly efficient ALUMINUM EXTRUSION SERVICE

PE facilities are complete from billet casting to finished extrusion and include the latest methods of scientific quality control. Our sole business is to produce high quality extrusions promptly at a reasonable price.

This PE specialization in producing aluminum extrusions (neither fabricating or manufacturing other products) is your assurance of immediate skilled attention to your inquiries. We can serve you promptly, efficiently, and at low cost on either standard shape or especially designed extrusions.

PE engineers have wide experience in all types of fabricating operations and can provide invaluable aid in helping create new aluminum extrusion applications that will cut manufacturing costs and improve product quality. Your inquiries receive personalized and confidential attention.



Write for Free Copies PE Extrusioneering News

New illustrated bulletin covers case studies of cost-cutting extrusion applications, includes helpful technical data for design engineers and purchasing executives and gives further facts on PE facilities.

SIMPLE, COMPLEX — LARGE OR SMALL

You'll find PE thoroughly experienced and well equipped to produce almost any type or size extrusion to serve your needs. There are over 5 000 standard PE shapes to select from—without a die service charge. PE Extrusioneering provides the answer for especially designed shapes.

PRECISION EXTRUSIONS, INC.

729 GREEN AVENUE BENSENVILLE, ILLINOIS

PHONE: BENSENVILLE 98 • CHICAGO TUxedo 9-1701

Chicagoland's Oldest Aluminum Extruder

professional employee. The struggle of engineers for true professional stature has increased the complexity of this problem. Indeed, our major concern is to see that these personal satisfactions are met and that each individual engineer receives proper recognition for his personal and technical contributions to the achievement of group goals.

Within the generally accepted limits of sicientific management, a large part of productive supervision lies in the area of good judgement, personal concern, and sound moral values. Where basic scientific management principles are established in an organization, tremendous improvement in the quality of supervision can be obtained by sufficientlv emphasizing responsibility for the solution of supervisory problems. Skill can be effective onlv in the company of supervisory and personal integritv. With these qualities and a reasonably high degree of intellectual and social intelligence present, additional skills in supervision mav be developed.

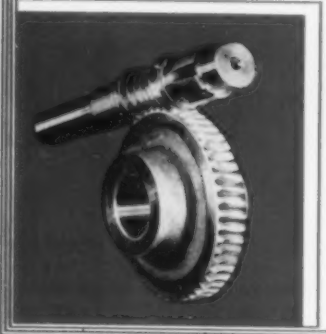
Much supervisory training is accompanied only by wretched indifference to sound policies and basic moral values. By a factor of several hundred per cent, the most important element in the improvement of supervision is the desire to surpervise well. This desire must be encouraged by the entire line organization giving close atention to supervisory problems, taking the time to coach as each opportunity occurs, and by giving sufficient top management emphasis to the necessity for high quality supervision at each level of the organization.

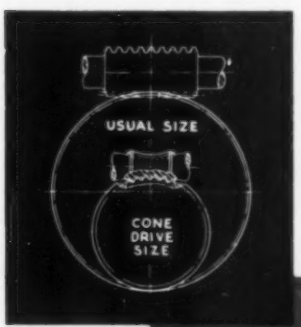
Managers and supervisors face the danger of losing "man-to-man" contacts with their employees. This displacement of the personal touch by an impersonal "machine-like" approach can cause serious problems. Important supervisory traits, such as leadership and creativeness, must not be replaced by statistical controls and a "supervise-by-the-book" attitude.

It should be no news that careful administration of performance standards provides one of the most effective means for job satisfaction. One of our divisions employing some 500 engineers has been particularly successful in the application of such quality standards. In our appraisal pro-

(Continued on page 446)

for concentrated power





. . . CONE-DRIVE gearing has no equal.

You can pass an amazing amount of power through a set of Cone-Drive gears.

Want to cut product size? Cone-Drive will give you a more compact gear train with reserve load capacity.

Want to boost power output and hold size? That's easy with Cone-Drive gears. They'll carry two, three, and four times the load of cylindrical worm gearing.

Why? In Cone-Drive gears, the load isn't concentrated on a small area per tooth or on just one or two teeth at a time. Cone-Drive's exclusive double-enveloping principle distributes the load over a lot of teeth and over more area on each tooth.

It cuts the unit loading the same way a pair of snowshoes supports a heavy man.

Ask for Bulletin CD-400 for complete details.

CONE-DRIVE GEARS
A Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

New stop clock designed for accuracy, versatility

Today's product designer, control systems engineer, nuclear physicist, and graphic panel manufacturer have a common need—an instrument capable of measuring elapsed time to a hundredth of a second, with an accuracy better than 0.02 of 1%.

Wide field—wide requirements

But there the sameness ends—the nuclear physicist needs a hermetically sealed device for remote control; the product designer requires load switches and local pushbutton reset; the graphic panel man wants smart appearance. The lab technician wants a portable model. The military asks for the smallest unit consistent with reliable readings, while the sports event timekeeper must have a large dial.

How can you meet these diverse requirements? Well, here's the answer to that question—a product of Cramer's experience and knowledge of precision timing.

Accuracy for everybody

You select a small, powerful and inherently accurate drive motor, add a 110-tooth positive clutch and apply it on the high-speed shaft. Back it up with a potent relay. When the signal comes, the unit responds instantly, and we have *accuracy*.

All-electric operation for flexibility

Add heart cams on the mainshaft and a rugged solenoid to belt them home within 1/10 second after the reset switch is operated. Now we have *electrical reset*, either remote or local.

For *versatility*, provide for load switches with cams on fast or slow pointer shafts. Cut and set at the factory, cams will offer a variable number (and duration) of pulses per second or minute, or with load switches wired in series, the unit can be used as a highly precise time delay relay or interval timer.

Commercial or Mil-Spec housings

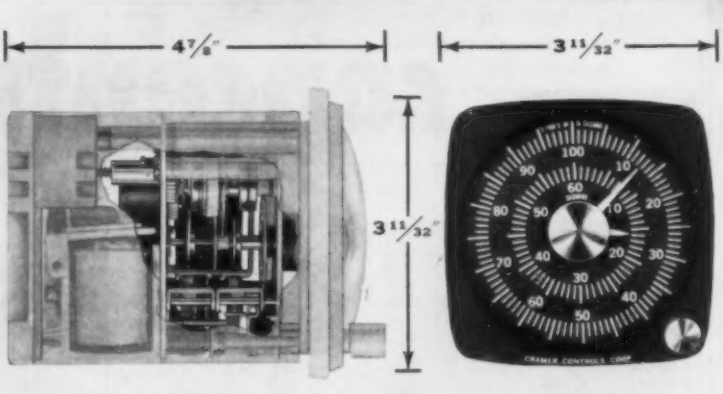
Now let's enclose the mechanism. Commercial housing is dust-tight and has a 12-place terminal block. Also developed: a militarized model to withstand high vibration, shock and severe environments. A deep-drawn solder-sealed enclosure with 14-pin glass-beaded header, evacuated and hermetically sealed will do it.

Dials, pointers—Loewy styled

What's left? The business end of things—dial and pointers. Let's tackle this for readability, and at the same time, shoot for eye-appeal. This time we'll go to the *styling* experts — famous industrial designers, Raymond Loewy Associates. They come up with the last word in human-engineered dial-pointer combination for fast, exact readings. Frame it with a pleasing bezel that can be finished to match or harmonize with your panels.

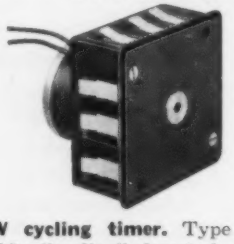
Now it looks like the precise instrument that it is—the new Cramer Type 691 Time Totalizer. Bulletin PB-691 tells more about it. Write for your copy today. The Cramer Controls Corp., Box 7, Centerbrook, Conn.

P.S. We've got the six-inch dial version and the portable model, too. 7.20

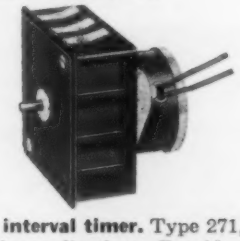


NEW time totalizer. Type 691 features instantaneous electrical reset, accuracy within 0.02 of 1%. Standard ranges: 60 seconds in 1/100 sec., 60 minutes in 1/100 min., and 60 minutes in seconds. Factory-set cam-operated load switches (rated at 5A, 250 vac, resistive) can be supplied. Available for standard voltages at 50, 60 cps; for 400 cps with d-c clutch; and for d-c voltages. Mechanical and electrical life in excess of 1-million operations.

TWO MORE NEW CRAMER PRODUCTS



NEW cycling timer. Type 571, ideal for "cycling" electrical equipment such as appliances, vending machines, advertising displays, at lowest possible cost. 1 to 4 poles. Speeds from 1 rpm to 1 revolution in 8 days with 30-amp contacts. Faster speeds with lighter contacts on special order.

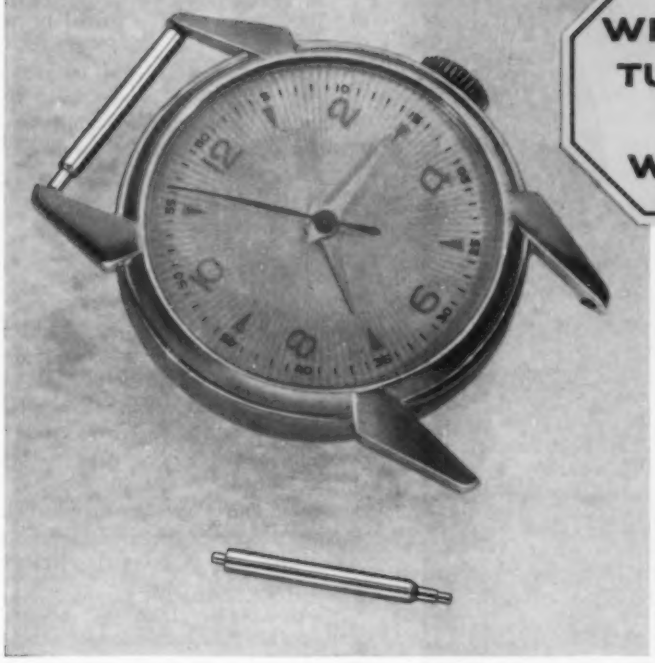


NEW interval timer. Type 271, for built-in applications. Provides an economical way of timing appliances, photo equipment, ovens, etc., for manually preset interval. 1 or 2 poles. Time ranges from 45 seconds to 6 days with 30-amp contacts. Normally furnished without knob or dial.

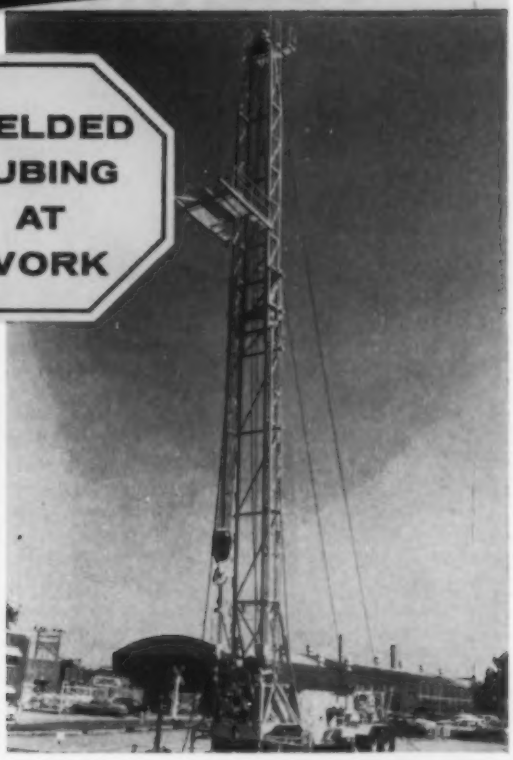
TALK IT OVER WITH

CRAMER CONTROLS
CORPORATION

Design with TUBING in mind!



WELDED TUBING AT WORK



Accuracy suitable for telescoping, strength for a vital service, corrosion-resistance to withstand body acids—all recommend Welded Stainless Steel Tubing for this tiny watch pin.

Great structural strength, lightweight for mobility, uniformity for inter-working parts—all recommend Welded Carbon Steel Tubing for this oil country drilling rig.

For maximum strength • minimum weight

CHOOSE WELDED TUBING IN ANY SIZE

Carbon • Alloy • Stainless Steel

The tubular form is one of engineering's most efficient sections—and Welded Tubing with greater uniformity about its axes is tubing at its best. Whether you have design requirements for great strength, light weight, high RPM, interchangeability of components, heat, pressure or corrosion—there is a size and grade of Welded Tubing to do your job best. For all tubing applications, consult a quality tubing producer.

An Association of Quality Tube Producers

FORMED STEEL TUBE INSTITUTE — FSTI

Design inspiration for you

The 260-page Handbook of Welded Steel Tubing contains inspiration and data for tubing designs. For your copy, write on your company letterhead, giving your title.

FORMED STEEL TUBE INSTITUTE
850 HANNA BUILDING • CLEVELAND, OHIO

Best low-cost way to incorporate variable-speed into machine designs

Choose from 8 sizes . . . ¼ to 15 hp . . . 1.75:1 to 4:1 speed ratio. Converts any standard constant-speed motor into variable speed drive.
MAXIMUM TO MINIMUM OUTPUT SPEED POSITIONS

REEVES®

Vari-Speed Motor Pulley

Specify this easy, economical way to efficient and versatile use of the machines you design. REEVES-equipped machines adjust immediately to a variety of production speeds, production processes . . . you substantially reduce design and capacity obsolescence.

Your REEVES representative will be glad to work with you on the application best suited to your design. Offices in principal cities—or write direct for Catalog K28C-V545.

REEVES PULLEY COMPANY

Division of RELIANCE ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

gram each engineer's performance is discussed with him by his supervisor at least annually. The engineer's performance is compared point by point with the description and requirements covering his own assignment.

The development of engineers and supervisors can thus be placed on a dynamic, progressive basis. Each successive appraisal discloses desirable changes in direction and emphasis of training. A review of the appraisals by management provides an invaluable criterion by which to judge the success of the entire personnel development effort.

Both the production problem of World War II and the growth of personnel administration have contributed to the confusion as to the amount of aid which employees should be given. It is basic to modern concepts of mental hygiene that problems not be solved for confused individuals, but that they be given the aid necessary to reach their own solution. It is important that employees be required to carry the responsibilities of their position and of themselves as normal men and women.

It might appear then that a solution to this dilemma would be the goal of helping employees help themselves. Thus we would provide the optimum in learning opportunities, personal development, personal satisfaction, and moral growth. This is the way toward better personal adjustment of employees and, consequently, better producing employees. By providing wide exchange of information, barriers have been broken.

The story of the management of engineers is the story of management. It is no way debasing to engineers to treat them as humans first. That engineers are professional men makes them more sensitive to the strengths and shortcomings of management. For the same reason, they are much more apt to recognize that the true function of management is to achieve the goals of the organization by enhancing individual productivity.

In short, when we do a better job of managing, our engineers will do a better job of engineering.

Abstracted from, "Human Factors in Engineering Management," by H. M. Miller, Jr., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., ASME Paper No. 56-F-12, presented at ASME meeting Sept. 10-12, 1956, Denver. Colo.

to market...to market...to buy INVESTMENT CASTINGS!

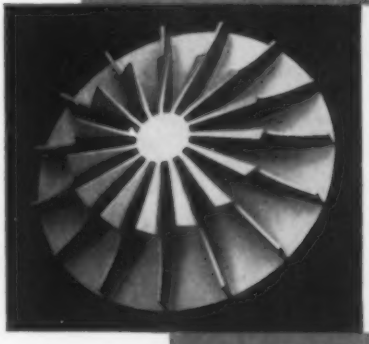
A single reliable "supermarket" for all of your precision casting needs? Yes sir! Regardless of size, complexity or material, all of your investment casting requirements can be met by Alloy Precision Casting Co — the nation's only foundry with both FROZEN MERCURY and LOST WAX facilities under one roof.

Not hampered by the limitations of a single process, Alloy Precision produces the most complete range of investment casting sizes (from less than 1/10 ounce up to 100 lbs.) in the most complete range of metals (including Magnesium and high temperature alloys).

Alloy's metallurgists, foundry engineers, designers and laboratory technicians control every step of production. Complete inspection facilities include all of the newest X-RAY, MAGNA-FLUX and ZYGLO equipment.

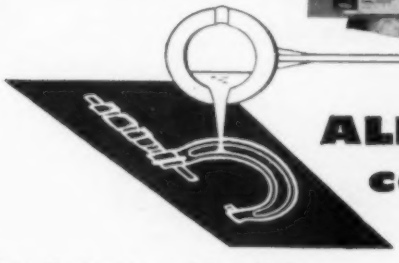
Many of America's outstanding industrial firms have come to regard Alloy Precision as their investment casting "supermarket" because of demonstrated skill, consistent HIGH QUALITY and deliveries made on schedule!

Insure the success of your investment casting designs! Send them to Alloy Precision Casting Co.



FREE GUIDES!

"HOW TO DESIGN, SPECIFY AND BUY INVESTMENT CASTINGS" literature includes description of Alloy Precision's modern plant and techniques. Write today! Send blue prints for quotes, design recommendations and value analysis to:



ALLOY PRECISION
castings company

Dept. 55 • 3855 West 150th • Cleveland 11, Ohio

A-1061

What's so *different* about Ampco Metal?

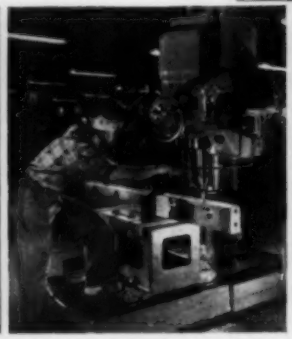
It's made to last — and does!

Not by chance, either! Ampco's pioneering experience in the development and production of special copper-base alloys has resulted in strict manufacturing precautions. These and the narrow metallurgical limits, the continual controls, the best in equipment and experienced personnel are all part of the Ampco secret. Yes, they're the big reasons why Ampco alloys enjoy world-wide acceptance — why so many manufacturers insist on the year-to-year uniformity and reliability that results from Ampco's "know-how" and controlled alloy-making procedures.

And because Ampco is made to last — and does — it performs its greatest service in those applications where severe load, wear, or corrosion problems must be solved.

Here's another thing that's different about Ampco Metal: It is produced by centrifugal-, sand-, or precision-casting, shell-molding, extrusion, and forging processes — on a production basis. It's also available as sheet or plate. Your Ampco field engineer can make unbiased recommendations, because Ampco offers this complete one-source service. Call him in. Also write for Bulletin 33.

Sand castings in any size up to 14,000 pounds — and centrifugal castings up to five tons — are produced in Ampco foundries.



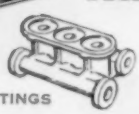
Ampco's one-source service includes production-run machining of copper-base alloys to the quality standards of the aircraft industry.

2,275-ton hydraulic press in Ampco's modern, laboratory-controlled mill for extruding rods, bars, hollow rounds, and shapes.

AMPCO METAL, INC. Dept. PE-5, Milwaukee 46, Wisconsin • West Coast Plant: Burbank, California

AMPCO®

THE METAL WITHOUT AN EQUAL



SAND CASTINGS

SHELL-MOLDED CASTINGS

CENTRIFUGAL CASTINGS

EXTRUSIONS

FABRICATION

SHEET AND PLATE

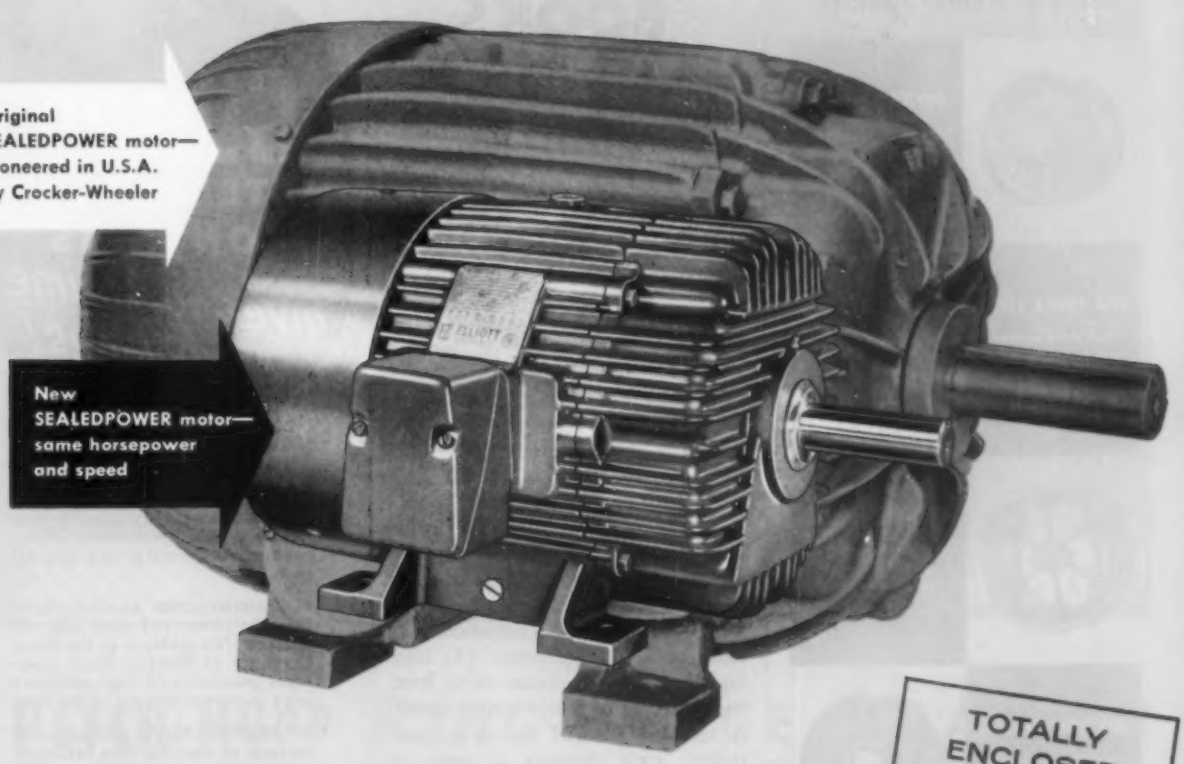
CAST-TO-SIZE CASTINGS

FORGINGS

MACHINED PARTS

D-54

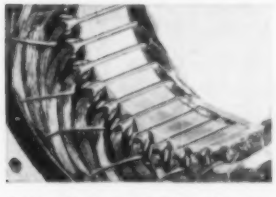
Inside and Outside . . . entirely new



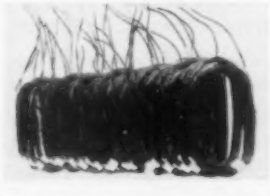
TOTALLY ENCLOSED FAN-COOLED FRAMES 284U-326U

NEW Elliott SEALEDPOWER Motors Produce MORE POWER per POUND

Superior Insulation Improves Motor Performance



Stator slots are lined with new, revolutionary synthetic materials having greater dielectric and mechanical strength than those previously used.

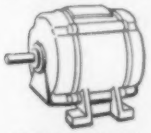


Motor coils are group-wound from continuous lengths of Vinylastic wire, with no brazed or soldered connections within groups.

In the new Elliott Crocker-Wheeler Type N motors, better utilization of copper, insulation, and electrical steel produces more horsepower per pound than earlier designs.

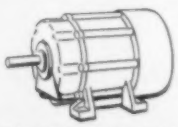
This is one of the *balanced design* factors that contribute to the outstanding performance of these motors. Others are highest quality electric steel, rigid frames and brackets, choice of anti-friction bearings to suit your operating and maintenance conditions, and a variety of highly effective enclosures, including dripproof, totally-enclosed and explosion-proof designs.

OTHER C-W TYPE N MOTOR ENCLOSURES



Totally-enclosed non-ventilated

Dripproof Protected



Totally-enclosed, fan-cooled Frames 256 U and smaller

ELLIOTT Company

CROCKER-WHEELER DIVISION

***WRITE* for new bulletin describing Elliott C-W Type N Motors. *Address:* Elliott Company, Crocker-Wheeler Division, Jeannette, Penna.**

W6-7

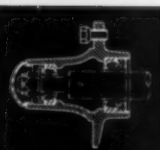
ELECTRIC
Wheels · Axles · Spindles

DIVIDED WHEELS
Generally used as dolly, tail or caster wheels

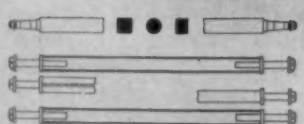
FOR TRUCK TIRES
Full drop center rim to utilize used truck tires on larger implements

PLANTER WHEELS
Steel rim or for use with planter rubber tires

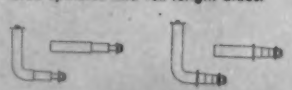
SIX BOLT SERIES
Light and heavy —widest range of implement use



Four bolt series for light implements



Hub and bearing combinations available.
Stub spindles and full length axles.



Our Engineers Invite Your Inquiries
ELECTRIC WHEEL COMPANY
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY
2805 SPRUCE · QUINCY, ILLINOIS

NEW BOOKS

Glass-Fiber-Reinforced Plastic Laminates

PB 121500, K. H. Boller, Forest Products Laboratory for WADC. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington 25, D. C. $2.50.

Although considerable data exists on static strength properties of structural plastics under standard conditions, and some data is available on fatigue strengths at room temperature, fatigue data at elevated temperatures are limited.

Information reported here covers fatigue tests at temperatures up to 500 F on six standard and four heat-resistant resin laminates reinforced with glass fibers. Factors investigated were: (1) stress concentration, (2) moisture, (3) temperature, (4) loading direction, (5) mean stress level, and (6) type of fabric reinforcement. A total of 53 S-N curves are presented, each covering a range of 1,000 to 10 million cycles. Results are correlated with stress-rupture data supplied by WADC on matched material.

Vibration Analysis Tables

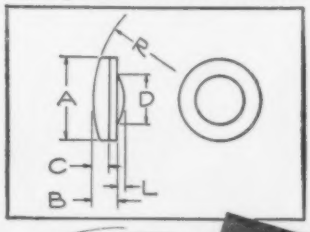
R. E. D. Bishop and D. C. Johnson. 8½ x 11 in., paperbound, 58 pp. Published by Cambridge University Press, 32 E. 57 St., New York 22, N. Y. $2.

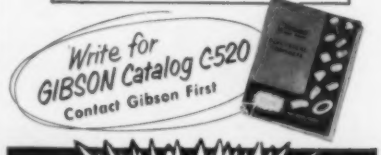
These tables may be used to simplify the calculation of the natural frequencies of conservative systems. They will help the engineer to find a close approximation of what he often wants to know—namely, those frequencies at which it would be dangerous to stimulate a system in the presence of light damping. Equally, if it is desired, a very close estimate can be made of the shapes of distortion of a lightly damped system at its resonant conditions, since these shapes differ little from the appropriate principal modes.

When it is necessary to estimate the response of a damped system to a given harmonic excitation at a near-

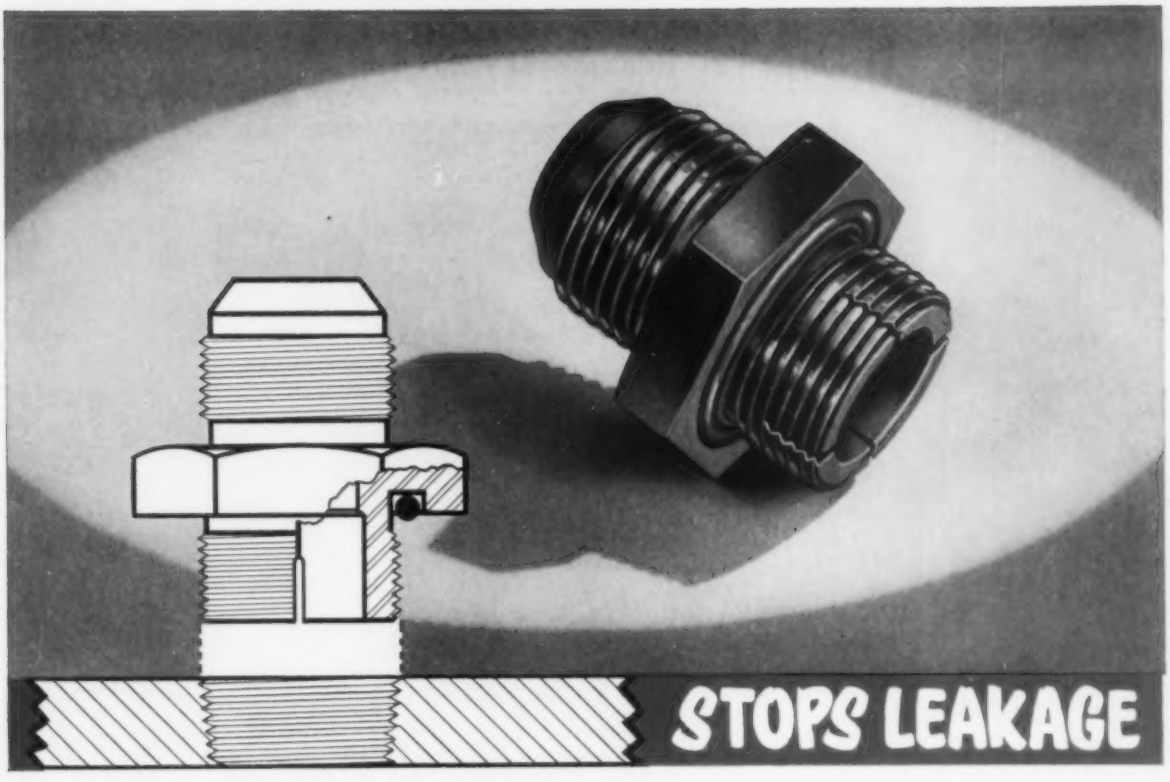
(Continued on page 454)

- **HIGH CONDUCTIVITY** Gibson steelback electrical contacts are made by individually bonding each silver facing to its steel backing. When steelback is welded to support, the bond provides a highly conductive electrical and thermal path.
- **PERMANENT BOND** Excellent bond between silver and steel will not separate. No solder is in the bond. Certainty of flawless bond eliminates possibility of high-resistance joint between facing and backing.
- **NO RUSTING** Nickel plating on all surfaces of steel backing before attaching silver facing assures freedom from rust.
- **ECONOMY** Nickel or monel can be used in place of steel as backing material to prevent costly rusting if backing is damaged. For standard-size steelback quotations, submit material desired, dimensions (shown below) and ordering quantity. Special sizes also available.





Gibsiloy
ELECTRICAL CONTACTS
Manufactured by
GIBSON ELECTRIC COMPANY
8358 Frankstown Ave., Pittsburgh 21, Pa.



PETCH-HUPP *RING-WEDGE* ADAPTER

NOW AVAILABLE TO STOP PIPE THREAD LEAKAGE WITHOUT SPECIFYING STRAIGHT THREADS

- Use with standard tapered female pipe threads
- No special tools required
- Tube end utilizes standard 37° Flare fitting elements
- RING-WEDGE male thread slotted allowing O-ring seal contact independent of port thread depth
- O-ring does not interfere with threads
- O-ring seals on port boss-spot face optional — no pipe sealing compound required

Part No.	Tube O.D.	Used w/ NPTF
821RW 6	⅜"	¼"
821RW 6-6	⅜"	⅜"
821RW 8-4	½"	¼"
821RW 8	½"	⅜"
821RW 8-8	½"	½"
821RW 8-12	½"	¾"
821RW 10	⅝"	½"
821RW 12	¾"	¾"
821RW 14	⅞"	¾"
821RW 16	1"	1"
821RW 20	1¼"	1¼"
821RW 24	1½"	1½"
821RW 32	2"	2"

PETCH PMC

SALES—463 York, Detroit 2
PLANT—Alpena, Michigan

MANUFACTURING COMPANY

PRINTED IN U.S.A.

H57 10M 1056

For the finest in Mechanization

JEFFREY CHAIN

makes good equipment better

Chain for transmission of power—providing maximum strength with minimum weight, but with ample reserve strength to withstand sudden and heavy overloads. Chain for every elevating and conveying need—built for rigorous and continuous service under the most trying conditions.

Jeffrey offers a complete line of chain, with sprockets and attachments to suit. Equipment manufacturers from coast to coast rely on these Jeffrey products to give their equipment greater dependability. Plant operators employ them to hold down costs.

Jeffrey chain and accessories are stocked for your convenience by your Jeffrey distributor. For help in selecting chain for any job, call them or get in touch with The Jeffrey Manufacturing Company, 788 North Fourth Street, Columbus 16, Ohio.

We can help you with modern, efficient equipment for Materials Handling • Chain Applications • Materials Reduction • Processing • Sanitation • Mining... and with a contract engineering-manufacturing service for your products. Jeffrey guarantees your enthusiasm!

JEFFREY

Founded in 1877

THE JEFFREY MANUFACTURING COMPANY • COLUMBUS 16, OHIO

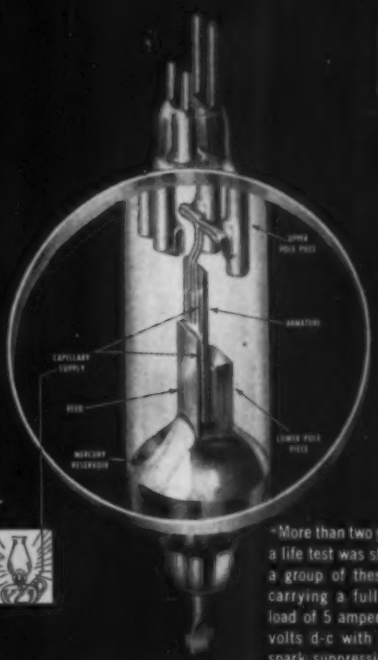
THIS CLARE RELAY IS *practically* FOREVER*

In many applications the right kind of relay will outlast and outperform any other circuit elements.

Even the most eager advocates of static switching systems—where static-magnetic and solid-state elements are used to accomplish functions usually performed by relays and other contact-making devices—now recognize this fact.

The Clare Mercury-Wetted-Contact Relay, for example, has a life of billions* of faultless operations. It requires no maintenance. It can switch from 250 volt-amperes down to a faint whisper of voltage and current. It is the best dry circuit relay in existence. More than that—it is completely free from contact bounce.

THIS is the relay that has become the main reliance of hundreds of leading designers of computing, data-processing and control equipment. For complete information write for Bulletins 120 and 122, C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: 659 Bayview Avenue, Toronto 17. Cable Address: CLARELAY.



CLARE RELAYS

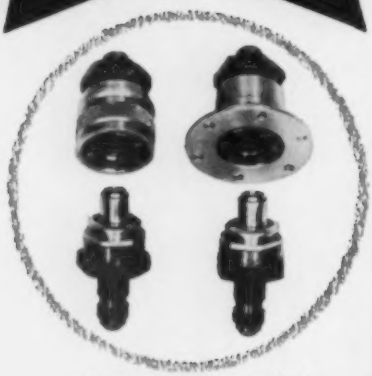
FIRST in the industrial field

*More than two years ago a life test was started on a group of these relays carrying a full contact load of 5 amperes at 50 volts d-c with suitable spark suppression. They have been operating continuously ever since at 5,184,000 operations a day. They are now approaching the 4-billion mark and the end is not yet in sight.

Wiggins

INST-O-MATIC
CONNECTION
quick disconnect
3000 psi

USE WIGGINS CONNECTIONS FOR
OIL
AIR
WATER
L P GAS
HYDRAULIC OILS
PNEUMATIC
GASOLINE
REFRIGERATION
COOLANTS
HELIUM
NITROGEN
AMMONIA
KEROSENE
FUEL OIL
DIESEL OIL
SIZES: ¼" to 2½"



Manual Quick Disconnect (Push-Pull Positive Action)

Automatic Quick Disconnect (Breaks Away at Pre-determined Weight Load)

The authority on connectors. Engineered for Reliability.

Wiggins

Write for information.

E. B. Wiggins Oil Tool Company, Inc.
3424 E. Olympic Blvd.,
Los Angeles 23, Calif.

Manufacturers of
INST-O-MATIC
WIG-O-FLEX
CONNECT-O-MATIC

resonant frequency, it is still possible to use many of the results that are presented. Thus a damping element, such as a viscous dashpot, may be regarded as a sub-system and the stiffnesses of the shafts in the torsional systems of the tables may be made complex. In general, the effect of introducing linear damping into analysis is to make receptances complex without otherwise impairing their usefulness.

Among the data given are receptances—that is to say, the measures of the readiness of the various systems to respond to harmonic excitations. These functions are themselves of importance in the analysis of lightly damped systems which are not excited at near-resonant conditions and they also may be used in connection with compound systems. This is because the frequency equation, the principal modes and the receptances of a system can be deduced when the receptances of its simpler parts are known.

Mathematics and Computers

GEORGE R. STIBITZ, *Consultant in Applied Mathematics, and* JULES A. LARRIVEE, *Worcester Polytechnic Institute.* 6 x 9 *in.*, 208 *pp. Published by McGraw-Hill Book Co.*, 330 W. 42 *St., New York* 36, N. Y. $5.

Mathematicians, scientists, and engineers can gain a better idea of the relationships between pure and applied mathematics and the growing use of automatic computers from this book. It surveys the work of the applied mathematician, the problems he studies, the methods he uses, especially computation methods, and the computing devices that help him in the application of mathematics to problems in science, engineering, and business.

Computing devices and their components are described, especially the automatic digital computer, the way it works, and its capabilities and limitations. Non-digital computing devices also are covered. A treatment of the use of randomness in computation, and typical applications of computing devices in technology and business are covered.

Of special interest are the broad over-all view given in the chapter on

(Continued on page 458)

Will stepped-up performance increase sales of your power equipment?

Specify ONAN
SHORT-STROKE, LONG-LIFE
ENGINES

Model CCK
12.9 H.P. 2-cylinder opposed . . . 4-cycle. Gasoline-powered.

Model AJ
5.5 H.P. One-cylinder. Gasoline-powered. 4-cycle.

Onan short-stroke, air-cooled engines give you a combination of performance characteristics which can add *powerful selling features* to your engine-driven equipment. They are designed for continuous service . . . to run hundreds of hours with minimum attention. Short-stroke, low-friction design, extra-large bearing surfaces, Stellite-faced exhaust valves, solid Stellite exhaust valve seats and many other long-life features give you a big premium in trouble-free service.

Onan engines are compact in all dimensions, light in weight, smooth running and easy starting. They deliver full rated power even under a variety of adverse conditions.

If stepped-up performance will sell more equipment for you, you can build in this extra saleability with Onan engines at no extra cost. Write us or call

D. W. Onan & Sons, Inc.
3823 Univ. Av. S.E., Minneapolis 14, Minn.

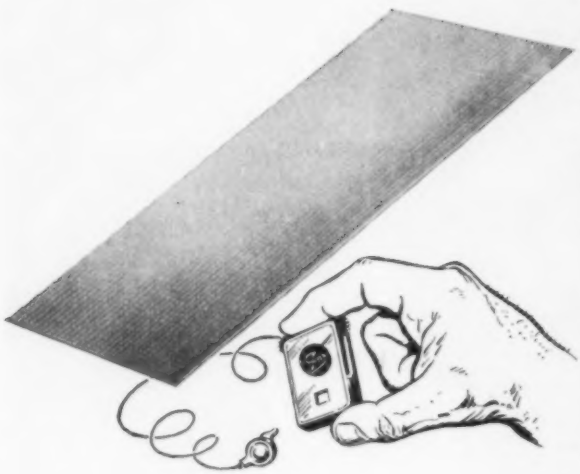
Lightweight, air-cooled Onan Diesel engine

Model DRP
Two-cylinder, opposed. 15 H.P. at 2300 R.P.M. 4-cycle. Solid injection, full Diesel. Electric starting. 12-volt generator. Full pressure lubrication.

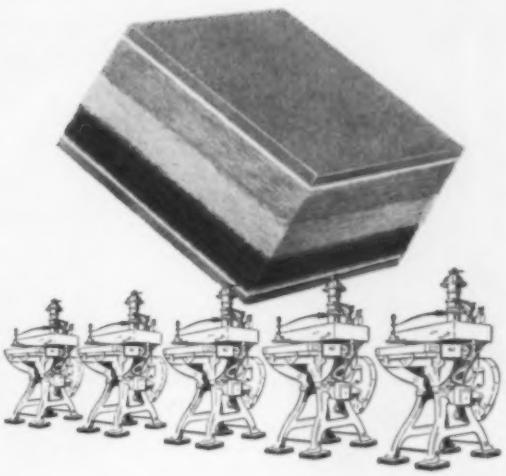
Onan ELECTRIC PLANTS

ONAN
AIR-COOLED
ENGINES

A paper-thin battery separator felt for hearing aids



. . . or Vibra-Mount felts to cut machine vibration*



Put the MAGIC *of American Felts to work for you*

New things are happening most every day at American Felt Company. Exciting things you never dreamed could happen with felts. The battery separator, for example, is made from one of our Feutron** Felts, a combination of synthetic fibers that makes this separator more resistant, longer lasting than the usual material employed.

On the other hand the unusual properties of wool fibers as combined in American's Vibra-Mount Felt eliminate as much as 85% of a machine's vibration, no bolts are needed to fasten machines to concrete or wood floors, "walking" of machines is prevented.

These are just two of the many uses for the felt wonders constantly being produced through the ingenuity of American's Research and Engineering Staff. Use your imagination and many more uses will come to mind.

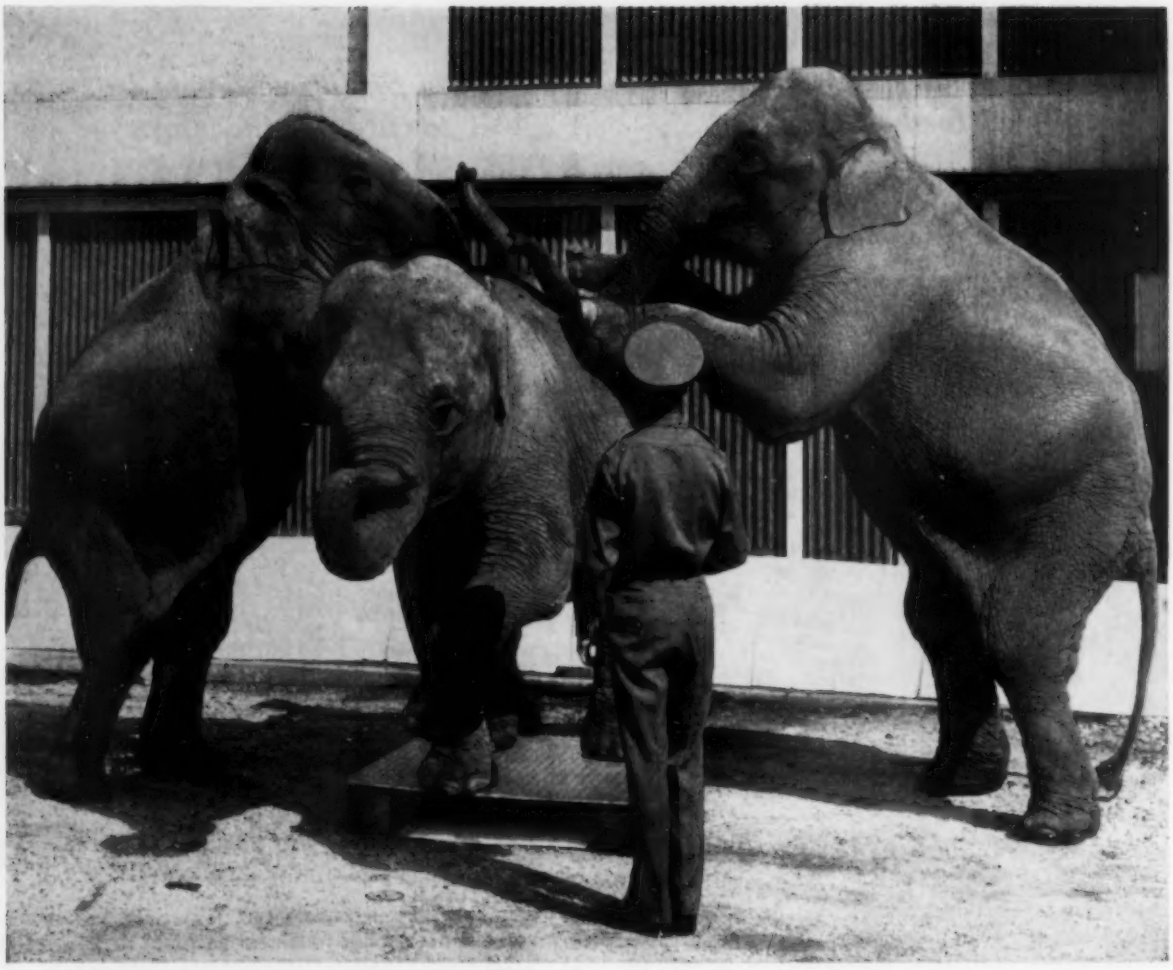
For the first things in felt it will pay you to call American first. Design with American Felts.

*Trademark Reg. **Trademark Reg.

American Felt Company
TRADE MARK

GENERAL OFFICES: 78 GLENVILLE RD., GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S. C., Dallas, Boynton Beach, Fla., San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.



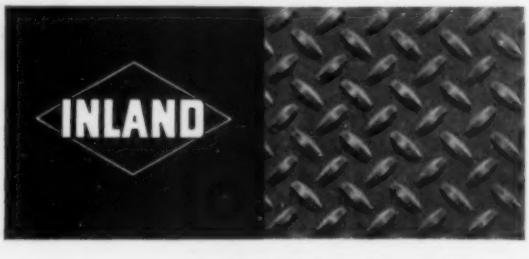
2-TON BABIES PROVE 4-WAY'S STRUCTURAL STRENGTH

These frolicsome 2-ton circus babies demonstrate the ability of Inland 4-WAY Safety Plate to support tremendous weights. Because of 4-WAY's rugged strength, this 4′ x 4′ plate bears up under 4,000 pounds of pudgy pachyderm without a hint of strain.

The extreme structural strength of Inland 4-WAY Safety Plate is an important factor in plant safety. 4-WAY is not just another flooring surface material, but a steel plate that can be used as a structural member.

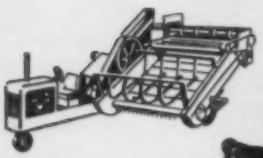
Strength, however, is only one of the advantages that 4-WAY offers. Its **slip-resistance, durability, attractive appearance, ease of application, fire resistance, ease of fabrication and cleanability** provide you with a combination of features unequalled by any other materials. Where can *you* use Inland 4-WAY Safety Plate? There are dozens of places in every plant where it can pay off in man hours saved . . . in providing safer, cleaner surfaces . . . in boosting general efficiency. For helpful suggestions and useful information, write to Dick Prendergast, Room 1262.

INLAND 4-WAY® SAFETY PLATE
INLAND STEEL COMPANY
38 South Dearborn Street • Chicago 3, Illinois
Sales Offices: Chicago • Milwaukee • St. Paul • Davenport
St. Louis • Kansas City • Indianapolis • Detroit • New York



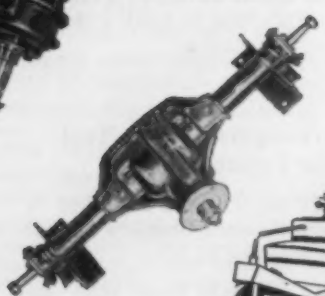
SPICER SUPPLIES MILLIONS OF AXLES FOR MANY DIFFERENT POWER-DRIVING NEEDS!

SELF-PROPELLED FARM IMPLEMENT



LIFT TRUCK

FIRE FIGHTER



GOLF CART

Spicer has over 50 years of power-transmission experience . . . has the most diversified corps of engineers in the industry . . . and has the industry's largest group of production facilities.

Spicer can design and manufacture axles for ANY type of light- and medium-duty motor-driven vehicle you produce! Spicer experience includes a wide range of axles for units such as:

Light and Medium Duty Trucks	**Golf Carts**	**Lift Trucks**
Passenger Cars	**Motor Scooters**	**Self-Propelled Agricultural Vehicles**
Road Markers	**4-Wheel Drive Trucks**	**Small Delivery Trucks**
Power Sweepers	**Mine Cars**	
	Fire Fighters	

and many other specialized types of vehicles.

Write for Spicer Axle Engineering Bulletin No. 364, and ask for an engineering conference on your particular axle requirements. We can supply your needs—*quickly and efficiently!*

DANA Spicer

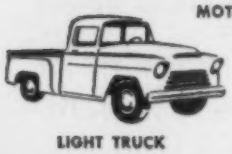
DANA CORPORATION

TOLEDO 1, OHIO

SPICER PRODUCTS: Transmissions • Universal Joints • Propeller Shafts • Axles Powr-Lok Differentials • Torque Converters • Gear Boxes • Power Take-Offs Power Take-Off Joints • Rail Car Drives • Railway Generator Drives • Stampings Spicer and Auburn Clutches • Parish Frames • Spicer Frames • Forgings

SPORTS CAR

MOTOR SCOOTER



LIGHT TRUCK

CASES, SHAFTS AND GEARS

POWER SWEEPER

FOUR WHEEL DRIVE TRUCK

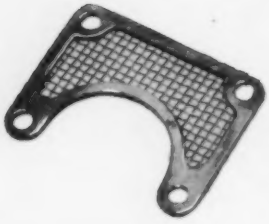
PASSENGER CAR

ROAD MARKER

Special WIRE CLOTH PARTS

save money

save time



no production problems

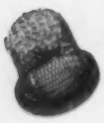
no quality problems

Newark is the place to come for your fabricated wire cloth parts. We can save you time and money. We weave our own wire cloth so you have no quality control problem. We take care of production scheduling . . . you have no idle manpower or idle machine time worries. We will give you a better part at a lower cost.

For more data on this phase of NEWARK Service, send for our Wire Cloth Parts Catalog. If you have an individual problem and would like to have us recommend the best way to insert the wire cloth piece send us tentative drawings and specifications. If you are ready to order, we'll be glad to quote.

NEWARK for ACCURACY

Visit the Newark Booth
#628 — the Design Show



Newark Wire Cloth COMPANY

351 Verona Avenue, Newark 4, New Jersey

numerical analysis, the chapter on the Monte Carlo method illustrated with examples which are easy to understand, and the explanation of the binary system and various binary codes leading to the language used by computers.

Applied Metallurgy for Engineers

MALCOLM S. BURTON, *Cornell University, 6 x 9 in., 407 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. $7.50.*

Written as a general college textbook designed to acquaint all engineering students with the foundations of metallurgy, this book will also serve as a handy guide to the practicing engineer whose college curriculum did not include such a course.

Perhaps the greatest virtue of the book lies in the fact that the author assumed its readers were not going to become metallurgists, so that he avoided all the topics which are so dear to the metallurgist but to no one else.

All the subjects treated are of wide interest to the mechanical engineer who has to design products and parts made from various metals. Shop lingo is kept to a minimum. The book covers the more common metals and alloys as well as the standard fabricating methods, and includes a chapter on powder metallurgy.

High Temperature—A Tool For the Future

8½ x 11 in., 218 pp. Published by Stanford Research Institute, Menlo Park, California. $5.

Man's efforts in many fields—engines, materials, chemical processes for example—have been limited by elevated temperatures. Interest in the wider aspects of high temperatures has been increasing in science and engineering, partly from the interest in high speed flight and nuclear power. In June 1956, Stanford Research Institute sponsored a three-day conference dealing with the broad spectrum of high temperature matters. This volume contains the reports presented at this conference.

(Continued on page 463)

"design it better— make it better"

is the guiding principle of

BORG-WARNER

ATKINS SAW—all types of hand, crosscut, circular and band saws, hacksaw blades, chainsaw chains.

BORG & BECK—for automotive clutches and torque converters.

BORG-WARNER INTERNATIONAL—for world-wide export service.

BORG-WARNER, LTD.—for timing, silent and roller chains and sprockets.

BORG-WARNER SERVICE PARTS—for national distribution of replacement automotive parts.

BYRON JACKSON—for agricultural and industrial centrifugal and turbine pumps, nuclear pumps, oil field products and services, electronic instruments.

CALUMET STEEL—for steel fence posts, structural steel tubing, reinforcing bars, steel shapes, channels, angles, bars.

DETECTOLAB—for radiation counting and measuring instruments; and precision electronic instruments.

EBERHARDT-DENVER—for speed reducers.

FRANKLIN STEEL—for steel fence posts, reinforcing bars, merchant bars (rounds, flats, angles, special sections).

INGERSOLL CONDITIONED AIR—for forced warm air furnaces, central air conditioners, water heaters, incinerators.

INGERSOLL-HUMPHRIES—enameled cast iron and steel bathtubs, sinks, lavatories; vitreous china water closets and lavatories; kitchen cabinets.

INGERSOLL KALAMAZOO—for amphibious landing vehicles, guided missile boosters, materials handling equipment.

INGERSOLL PRODUCTS—for plow and harrow discs, farm implement parts, automotive stampings, washing machine tubs, porcelain enameled steel sinks and bathtubs, roof deck, cranes and hoists, electric furnace carbon and alloy steel plate.

INGERSOLL STEEL—for special purpose steels, forging quality ingots, automotive clutch discs, tillage discs, hand shovels.

LONG MANUFACTURING—for torque converters, clutches, radiators, oil coolers; tractor axles and hydraulic pumps; automotive and aircraft gears and precision parts.

LONG MANUFACTURING CO., LTD.—for automotive clutches, radiators, oil coolers.

MARBON CHEMICAL—for rubber-to-metal adhesives, synthetic and high impact thermoplastic resins.

MARVEL-SCHEBLER PRODUCTS—for automatic transmissions, nuclear manipulators, carburetors, power brakes.

MECHANICS UNIVERSAL JOINT—for roller bearing universal joints and propeller shafts.

MORSE CHAIN CO.—for timing, silent and roller chains and sprockets, flexible couplings, speed reducers, free wheeling and indexing clutches.

MORSE CHAIN OF CANADA, LTD.—for automotive timing chains and sprockets, industrial and agricultural chains.

NORGE—for household appliances; aircraft and guided missile airframe structures.

PESCO PRODUCTS—for aircraft hydraulic and fuel pumps, agricultural and industrial hydraulic pumps, valves, electric motors.

REFLECTAL CORP.—for aluminum foil reflective insulation.

ROCKFORD CLUTCH—for automotive, industrial and agricultural clutches, power take-offs, gear reduction units.

SPRING—for torque converter parts, sprag type clutches, automatic transmission parts, precision springs.

WARNER AUTOMOTIVE PARTS—for automotive replacement parts, agricultural and industrial gear boxes, automotive and industrial gears and power take-offs.

WARNER GEAR—for standard and automatic transmissions, Overdrive units, parking brake assemblies, synchronizer assemblies.

WARNER GEAR CO., LTD.—for automotive synchronizer units.

WESTON HYDRAULICS, LTD.—for precision hydraulic and pneumatic equipment for aircraft and guided missiles.

WOOSTER—for aircraft hydraulic pumps, fuel pumps, electric-driven accessories.

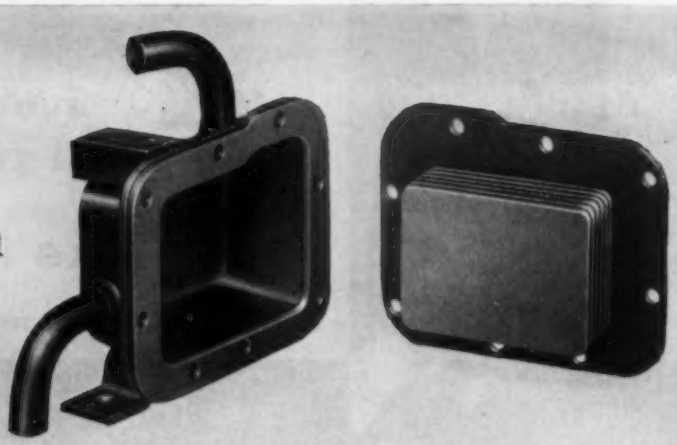
YORK—for domestic, commercial and industrial air conditioning equipment.

ENGINEERING B-W PRODUCTION

BORG-WARNER CORPORATION

310 S. MICHIGAN AVENUE • CHICAGO 4, ILLINOIS

Better Engine Operation with Oil Coolers



Heat dissipation in limited area accelerated by new, plate-type unit

The ever higher performance being built into modern engines is creating new problems in heat dissipation. Engine efficiency, pressures and operating speeds have increased. So have operating temperatures of the engine parts. But the surfaces and area available for dissipating heat may be unchanged or even smaller. Therefore, more heat is drawn into the lubricating oil of the engine.

Although friction losses in percent of total power output are dropping, the absolute rate of heat generated has gone up. This heat may exceed temperatures which the bearings are designed to resist and may rise to destructive levels.

In commercial vehicle, marine and industrial engines, heavy work loads are usually frequent or constant enough to require an oil cooler to maintain viscosity and to augment heat rejection. Such a unit may be attached to the engine or built into the engine block.

LARGE CAPACITY IN SMALL UNIT

To facilitate concentrated heat dissipation in a small space, Long Manufacturing Division of Borg-Warner Corporation has developed a compact, plate-type heat exchanger with large heat rejection capacity for its size. The unit is applicable on or in any engine requiring lubricant cooling. Current applications extend to 400 btu/pm. The element's rectangular shape is proportioned to be readily adaptable to a small aperature in the block where water can be circulated.

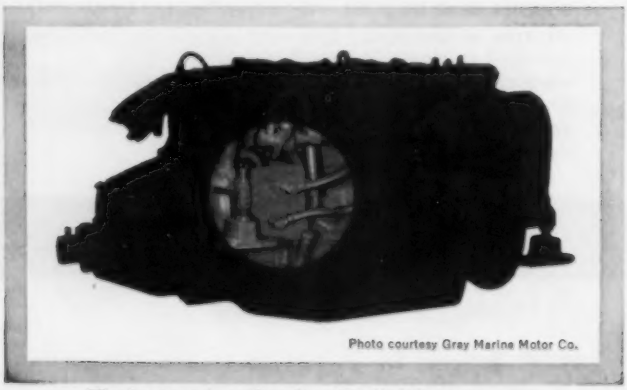


Photo courtesy Gray Marine Motor Co.

The Long engine oil cooler, installed here on a new marine engine, is small, unobtrusive, easily accessible.

It can also be used for any oil cooling application, such as in transmissions, torque converters and hydraulic presses.

The high efficiency of this cooling element lies in the diagonal flow path of the oil across the plates, utilizing the maximum possible length of the unit. Location of the fittings gives high velocity turbulence and effective oil distribution.

Spacers are placed between the plates to allow free circulation of the cooling water around this core. The assembly is then brazed into an integral structure. Counter-flow paths of the oil and water assure maximum heat exchange efficiency.

The turbulators are designed to minimize the pressure drop across the plates. Ingenuity in designing flow paths and stack arrangements of a single design element, according to the operating requirements, contributes to the economy of the unit. Any reasonable number of plates may be assembled in parallel, in series, and in parallel series.

RUGGEDNESS AT LOW COST

Manufacturing the casing (in accessory applications) from steel stampings instead of fabricating it from castings is a unique, cost and weight saving feature. Paint protects the exterior while the waterside is clad with rust- and corrosion-resistant cupronickel. The plate shells enclosing the mild steel turbulators are formed from stampings of solid cupronickel.

On the waterside this heat exchanger may be readily cleaned and the multiple-plate core can be removed from the casing without disturbing the water connections.

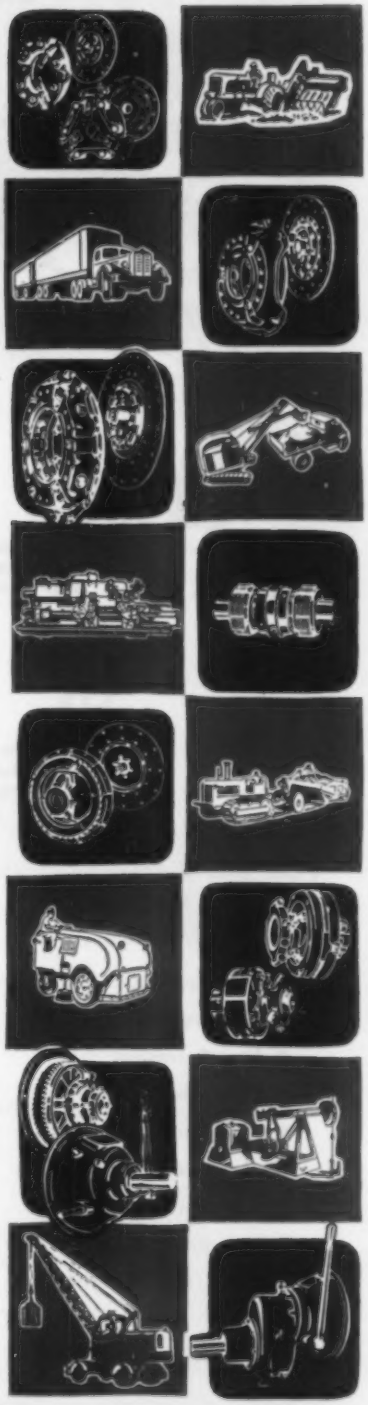
Traditional Long engineering and craftsmanship assures the quality, efficiency and dependability of this oil cooler. It is the first in a series of new products from this 53-year old manufacturer of heat exchangers, clutches and torque converters.

An engineering bulletin, including basic heat transfer and pressure drop charts from performance tests at Long Laboratories, may be had on request. The data also lists information requirements for obtaining recommendations on specific applications of this and other types of oil coolers.

Write to Dept. OC 1, Long Manufacturing Division, Borg-Warner Corp., 12501 Dequindre Street, Detroit 12, Michigan. In Canada: Long Manufacturing Company Limited, Oakville, Ontario. Export Sales: Borg-Warner International, 36 South Wabash Street, Chicago 3, Illinois.

ROCKFORD

For Every Industry and Application



Our engineers are not restricted to the application of one, two or three types of clutches. When you submit your clutch problem to us, we are in a position to recommend and supply a type and size clutch that is exactly suited to your need.

ROCKFORD Spring-Loaded CLUTCHES

permit convenient control and smooth gear changes under conditions requiring almost constant engagement, with only short periods of disengagement — maintained by foot-pedal or hand-lever pressure.

ROCKFORD OVER-CENTER CLUTCHES

lock in "engagement" or "release" position, providing positive control during long periods of engagement or disengagement operation.

PULLMORE Multiple-Disc CLUTCHES

provide smooth starting and powerful, hand-operated control, within limited space.

ROCKFORD Power TAKE-OFFS

and Speed Reducers are complete, self-contained units. Available with heavy duty, gear-tooth drive "over-center" type clutch equipment. Sizes to fit standard S. A. E. flywheel housings.

ROCKFORD Morlife* CLUTCHES

Because of their specialized characteristics, MORLIFE type ROCKFORD clutches are best suited for use in off-the-road machines such as tractors, trucks, tanks, cranes, shovels, bulldozers, earth movers, pipe layers, power units and other heavy duty equipment.

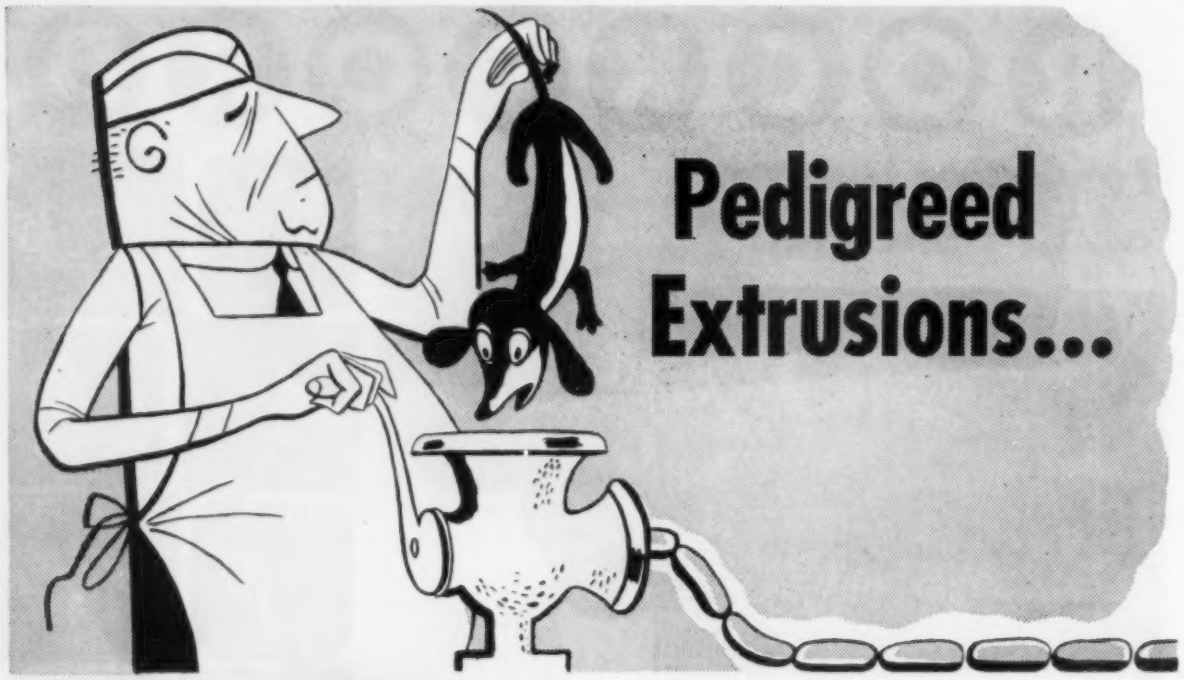
Let our engineers give you the benefit of their more than a quarter century of clutch building experience to specify the size and type clutch to meet your need exactly. Write for bulletin covering the ROCKFORD clutch or power take-off that fits your product.

ROCKFORD Clutch Division BORG-WARNER

1319 Eighteenth Avenue, Rockford, Illinois, U.S.A.

Export Sales: Borg-Warner International — 36 So. Wabash, Chicago 3, Illinois

CLUTCHES



Pedigreed Extrusions...

with...

CYCOLAC®

New HIGH-IMPACT THERMOPLASTIC RESIN

THE PERFECT RESIN FOR THE MANUFACTURE OF ANY PRODUCT THAT DEMANDS . . .

- Chemical Resistance
- Lightweight
- Non-Corrosion
- Dimensional Stability
- High Impact Strength
- Machineability
- Economic Molds
- Low Brittle Point
- High Heat-Distortion

Extrusion . . . Calendering . . . Injection Molding . . . It's CYCOLAC for any or all Three Methods

Extruded items for high production of sheet, pipe, or profiles; calendered sheet stock for post-forming operations; injection molded items for high gloss, dimensional stability. All products characterized by high impact resistance, bright colors, chemical resistance, low brittle point, low creep and excellent electrical properties.

Get the Facts...
Write Today for TECHNICAL LITERATURE

MARBON CHEMICAL
Division of BORG-WARNER
GARY, INDIANA

MARBON CHEMICAL . . . *Precision Resins for Precision Made Products*

Primarily concerned with the question, "Where are we going," these reports cover three basic areas: (1) methods for reaching high temperatures, (2) materials for containing them, and (3) processes occurring at high temperatures. These papers, 36 in all, are authored by experts in their fields; some are highly complex and of interest only to the researcher, others are less highbrow and of definite interest to the average materials engineer. T. H. Von Karman's essay on the "Temperature Barrier in Aeronautics", in particular, is most interesting.

Cast Copper Anti-Friction Steel

A. A. Lunev, *translated from the Russian by Science Translation Service. 8½ x 11 in., paper cover, 10 pp. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington, D. C.* $0.50.

Copper-bearing steels have not been developed commercially because of the tendency of copper to segregate out of solution on cooling. Introduction of a third element promotes stabilization of the alloy during melting and casting, reduces gas absorption and increases corrosion resistance in the solid state. Aluminum is especially useful as a third metal, as it imparts good wear resistance characteristics.

Copper content must be greater than 26 per cent to be effective, best range being between 26 and 32 per cent. Lead additions reduce the dry friction coefficient of copper steel and improve its machinability without affecting life.

Elements of Engineering Thermodynamics

Rolf H. Sabersky. *6¾ x 9¼ in., 318 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $7.50.

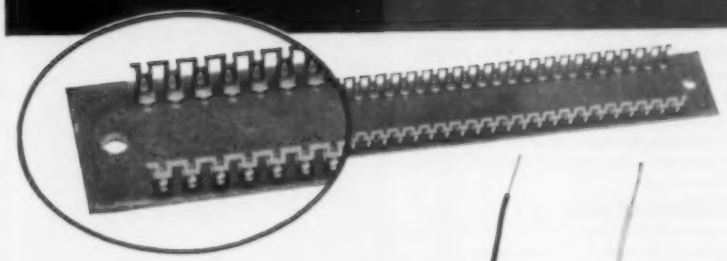
In this text for a first course in thermodynamics, the elements of compressible flow are more extensively and more carefully treated than in most books.

Principles of thermodynamics are developed as rigorously as a first

(Continued on page 466)

another *New* concept in component packaging . . .

by ERIE Electro-Mechanical DIVISION



THE ERIE STRIP PACKAGE SYSTEM

FEATURING:

- **Automatic clip assembly**
- **Automatic connector cutting**
- **Automatic component soldering**

RESULTS:

- **Lower production costs**
- **Higher reliability in solder connections**
- **Easier servicing**

ERIE supplies the customers' complete component package: electronic components, molded plastic parts, metal stampings, and embossed wiring boards available from various ERIE divisions; as well as other components purchased from other manufacturers.

For more complete information regarding the ERIE 3976 Strip Package, and its practical application in the solution of your individual problems, write to Engineering Department, Electro-Mechanical Division, Erie Resistor Corporation.

ERIE electro-mechanical

ERIE ELECTRO-MECHANICAL DIVISION
ERIE RESISTOR CORPORATION
Main Offices: ERIE, PA.
Factories: ERIE, PA. • HAWTHORNE, CALIF.

HOWELL MOTOR BRIEFS

Quick facts for those who design-in and specify electric motors

Gearmotors — speed . . . *and cost* . . . reducers!

Where driven speeds less than normal motor speeds are required, there are good reasons for using a gearmotor as opposed to a motor-plus-reducer-plus-coupling arrangement. Here are some of them:

1. **LOWER FIRST COST** is a big advantage—see table in adjoining columns for some specific comparisons.
2. **COMPACTNESS** that can give you significant space savings — plus a *better looking* drive.
3. **STANDARDIZATION** — fewer parts for you and your customers to stock. NEMA-standard gearmotors, like Howell's, are completely interchangeable — Howell ships them from stock.
4. **GREATER RELIABILITY** — With one integral unit and direct coupling, chances for wear and failure are greatly reduced.

Gear Hardness Counts

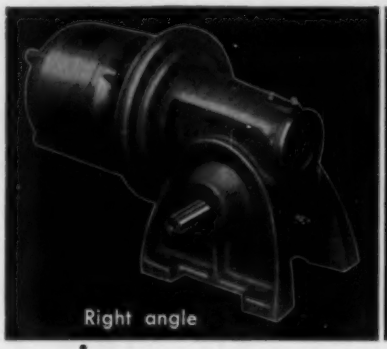
The degree of compactness and reliability you get in a gearmotor is dependent in good measure upon the hardness of the gears. Howell's parallel shaft units have gears machined to close tolerances from steel substantially harder (Rockwell 52-60) than is average in the industry. Result — a smaller gear package with superior wear resistance. Howell right angle units have precision ground steel worms integral with shaft, and worm gears made of high grade alloy bronze.

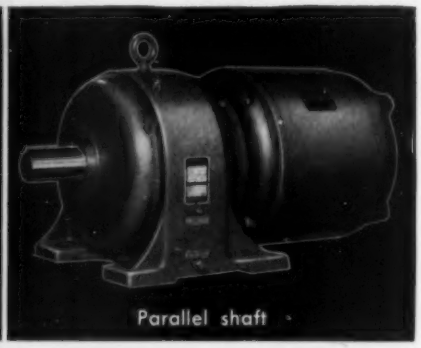
The right angle type of gearmotor is a recent addition to the Howell Motor line and complements the parallel shaft series. A Howell sales engineer will be glad to show you which is best for your application.

Note This Versatility

Howell is one of the few manufacturers to offer gearmotors with the motor of any electrical or mechanical type. Electrical types available include elevator and hoist, slip ring, torque and multi-speed motors.
Mechanically, they can be supplied in various types of enclosures — either with feet or with flanges for mounting horizontally or vertically. Optional accessory equipment includes brakes and zero speed switches.

Howell Gearmotor Capacities:
Parallel Shaft: 1 to 150 hp
Right Angle Shaft: ⅛ to 40 hp


Right angle


Parallel shaft

***savings*— Howell Gearmotors vs. Separate Motor, Reducer, Coupling and Base — based on open motor and Class I gears**

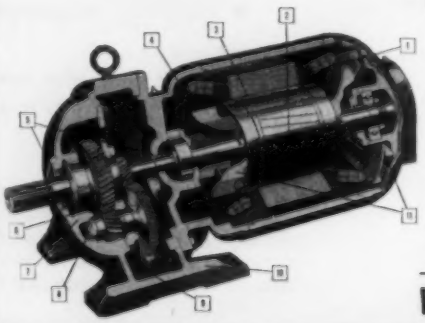
I. **Ratio 11.4 to 1 or 155 RPM with 1750 Motor**

HORSEPOWER	GEARMOTOR SIZE	REDUCER SIZE	GEARMOTOR SAVINGS*
1	21A-203	21-SL	$106.76
1½	21A-204	21-SL	82.38
2	21A-224	21-SL	60.12
3	21A-225	21-SL	28.32
5	21A-254	22-SL	35.52
7½	23A-284	23-SL	101.10
10	23A-324	23-SL	52.70

II. **Ratio 86.5 to 1 or 20 RPM with 1750 Motor**

1	32A-203	32-SL	$ 71.30
1½	33A-204	33-SL	134.08
2	33A-224	33-SL	78.96
3	34A-225	34-SL	154.42
5	34A-254	34-SL	43.06
7½	35A-284	35-SL	236.80
10	35A-324	35-SL	111.40

*Complete cost breakdown furnished on request



11 reasons why Howell Gearmotors last longer, serve you better

1. High-quality insulation
2. Copper-clad rotor
3. Expert Craftsmanship
4. High-quality coil varnish
5. Leakproof oil seals
6. Duti-Rated Lifetime Gearing
7. Unit case construction with integral bearing housings
8. Corner-mounted offset shaft
9. Large oil reservoir
10. Heavy, cast-iron construction
11. Superior cooling

Write for Bulletin GM-1

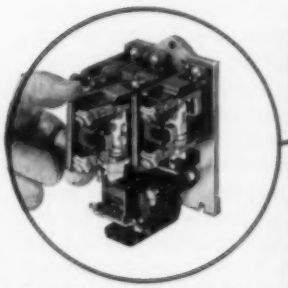
HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

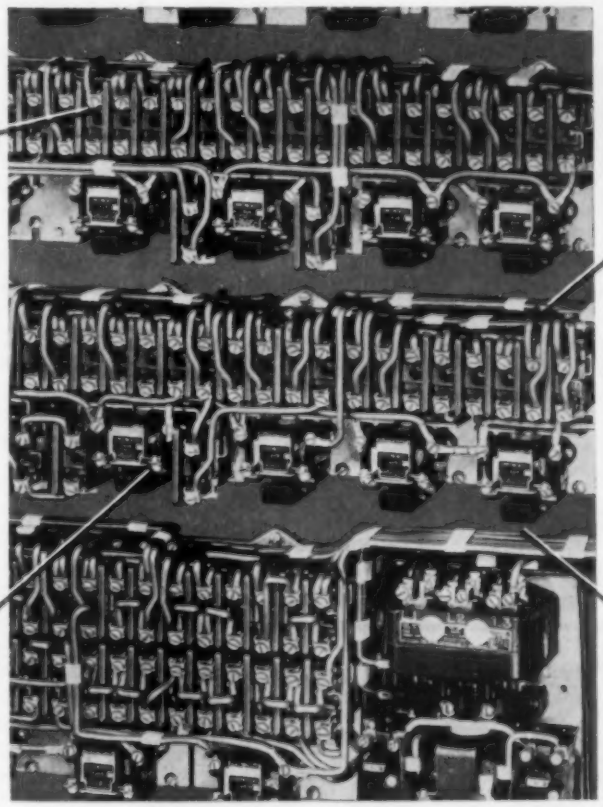
PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

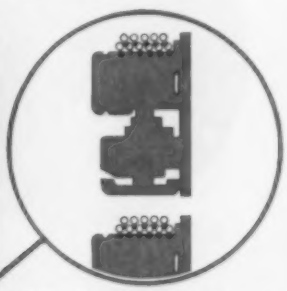
Why CLARK Type "PM" RELAYS give you more contacts per square foot of panel space!

Unique Features Produce Rugged Yet Compact Heavy-Duty Relay...

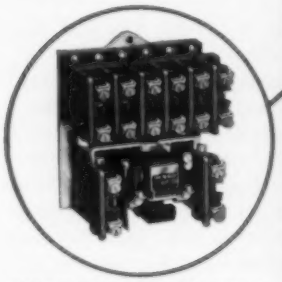


SECTIONAL POLE CONSTRUCTION. A Clark exclusive... With each pole in its individual melamine chamber, space between relays for electrical clearance is unnecessary. Front-mounted terminals eliminate need for extra side clearance. Sides of contact blocks are flush with edges of mounting plate.



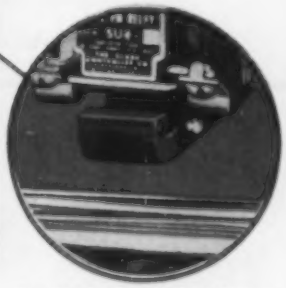


BUILT-IN WIRING SHELF... The melamine tops of the pole assemblies provide an insulating shelf free of current-carrying parts. Wiring can be bundled or laid flat right on top of the relay, saving additional space between rows. When wiring troughs are desired, they can be placed much closer to the top of the relay. This feature is another Clark exclusive.

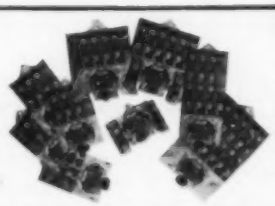


EIGHT-POLE SINGLE DECK... Only Clark makes it possible to have an eight-pole relay with single-deck wiring. At the same time, it uses every square inch of space on mounting plate, and lines up perfectly with Clark 2, 3, 4 and 6-pole single deck relays.

UNIFORM DIMENSIONS... Clark type "PM" relays are an integrated line designed so that they can be mounted side by side in perfect alignment with each other. In addition, the double-deck models have identical mounting dimensions with Clark type "CY", size 1 starters. Result: Neater, more uniform and more compact control panels.



1/2" MAGNET CLEARANCE... That's all the space needed to remove magnet and change coil. In overall panel construction and layout, this feature saves space by reducing amount of space between rows.



FREE TEMPLATES!

FREE TEMPLATES! Write for kit of actual-size photo-templates of type "PM" relays mounted on heavy cardboard. A great time-saver in laying out control panels. Each template has detailed dimension drawing and pole arrangement on the back.

The **CLARK CONTROLLER** *Company*

Everything Under Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

NOW!
new
economies in
NYLON
GEARS
means savings in gear costs up to 90%
Our many years of successful production of Nylon Gears can now make even greater economies for you. With the great variety in molds now possible, Nylon should not only be considered as an economy measure but the answer to many problems where compact design is necessary. Nylon Gears are quiet, durable, efficient and need less lubrication—they mate perfectly with metal gears.
Let our engineers with more than a decade in gear experience consider your gear problems DURING the design process—send blueprints or specs for prompt estimates.
Gears made only to your specifications. None carried in stock.
107
PROCESS GEAR CO., INC.
4601 W. Fullerton • Chicago 39, Illinois

course permits. Basic laws are stated, and experimental foundations are discussed. In deriving consequences from basic laws, assumptions are emphasized, and care has been exercised to distinguish between basic laws and derived relationships, which are valid in more restricted cases only.

In applications of thermodynamics to various engineering problems, industries which at present employ the largest number of engineers are particularly considered. Problems in the text form an integral part of the presentation, and their solution and discussion are integrated in the development of the subject. Several difficult problems are worked out as examples. References for further study, particularly in special topics, are given.

Transistor Manual

8½ x 5½ in., 62 pp, paper-bound. Published by Semiconductor Products Dept., General Electric Co., Syracuse, N. Y. $0.50.

Contains basic semiconductor theory, transistor fabrication techniques, basic principles of transistor circuit design and specifications. Nineteen circuit diagrams from a one-transistor audio-amplifier to a six-transistor superheterodyne receiver, together with complete parts lists are also included. A cross-reference chart gives replacement data for transistors in transistorized radios.

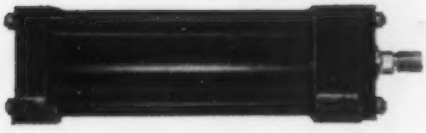
Transistors Handbook

WILLIAM D. BEVITT. *5¾ x 8½ in., 410 pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. $9.*

This book is concerned with the practical aspects of transistors. The beginning chapters deal with fundamental concepts, and present different types of transistors, their characteristics, measurements, circuit properties and behavior. The last half of the book discusses practical applications and transistor circuits, together with sound methods for their analysis.

Diagrams of tested circuits, with typical values of the circuit elements, where possible, are also included. Nearly 400 illustrations, and a minimum emphasis upon mathematics,

(Continued on page 468)



Five cylinder series... each the best of its kind!

Here you see one more reason why experienced cylinder users prefer Hannifin cylinders...there is a Hannifin cylinder series for every type of service.

What pictures cannot show you is the extra effort that goes into every Hannifin cylinder, all the way from the drawing board to the shipping dock. This brings you design features other cylinders simply do not have...superior workmanship where it's most needed for long, trouble-free service...and better delivery promises, better kept. All at prices no higher than you may have been paying for less satisfactory cylinders.

There's a Hannifin man near you—or, if the need is urgent, call us long distance. He or we will welcome the opportunity to help you as you select the Hannifin cylinder series that best meets your needs.

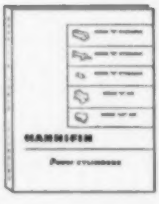
AIR AND HYDRAULIC

HANNIFIN

POWER CYLINDERS

COMPLETE CYLINDER FILE

Write for your copy of this new Hannifin Cylinder File...complete, easy-to-use, easy-to-order-from information on five lines of Hannifin cylinders. Write Hannifin Corporation, 525 S. Wolf Road, Des Plaines, Illinois.



THE SHAPE OF THINGS IN MOLDED RUBBER

MOLDED BOOT MINUS STOCKINGS
CUTS COST FOR LIFT TRUCK MANUFACTURER

APPLICATION:
Protective boot for hydraulic lift and tilt mechanism on gasoline powered lift truck.

PROBLEM:
This manufacturer's print specified a molded boot with stockinette base. Boot had to have good sunlight resistance; resistance to hydraulic oils, automotive greases and dirt; also, it had to maintain good flexing characteristics without checking or cracking.

SOLUTION:
Acushnet engineers and lab chemists were successful in eliminating the use of stockinette as a base for the rubber covering. The boot was compression molded entirely of an APCO neoprene compound which met all specifications. To effect further cost reductions, the flange area and holes were died out, permitting a choice of round or diagonal shaped mounting area. This resulted in a saving in mold cost and produced a cleaner, more precise part.

Designing a new molded rubber or silicone part? Immediate technical assistance now available from Acushnet in part design, custom compounding and molding techniques can effect substantial savings in production costs.

Send for Acushnet "Rubber Data Handbook."

What's Your Shape?

Acushnet

ACUSHNET PROCESS COMPANY
NEW BEDFORD, MASSACHUSETTS
... *Precision Molded* RUBBER, SILICONES - "APCOTITE" BONDING

Address all communications to 768 Belleville Ave., New Bedford, Mass.

make it readily usable by both technician and engineer.

A comprehensive subject index is provided for quick and easy reference to text material, and a convenient chart listing commercially available transistors, together with characteristics, is given in the Appendix.

Terminal Markings for Electric Apparatus

Sponsored by NEMA. 8½ x 11 in., paper-bound, 52 pp. Available from American Standards Assn., Inc., 70 E. 45 St., New York 17, N. Y. or National Electrical Manufacturers Assn., 155 E. 44 St., New York 17, N. Y. $1.

Under NEMA sponsorship, this fifth edition has been prepared as an American standard on terminal markings. This revised standard was approved as an American standard on May 11, 1956.

The current revision consists of a general updating of the information and a considerable expansion of the material on single-phase motors. It presents a system of connections and of markings for terminals for electric equipment, including generators, motors, converters, transformers and power control apparatus, together with the auxiliaries ordinarily furnished with such apparatus.

Automatic Data Reduction

PB 111928, Part II; R. S. Hollitch, Albert K. Hawkes, *Armour Research Foundation of Illinois Institute of Technology. 8½ x 11 in., paper-bound, 74 pp. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington, D. C. $2.*

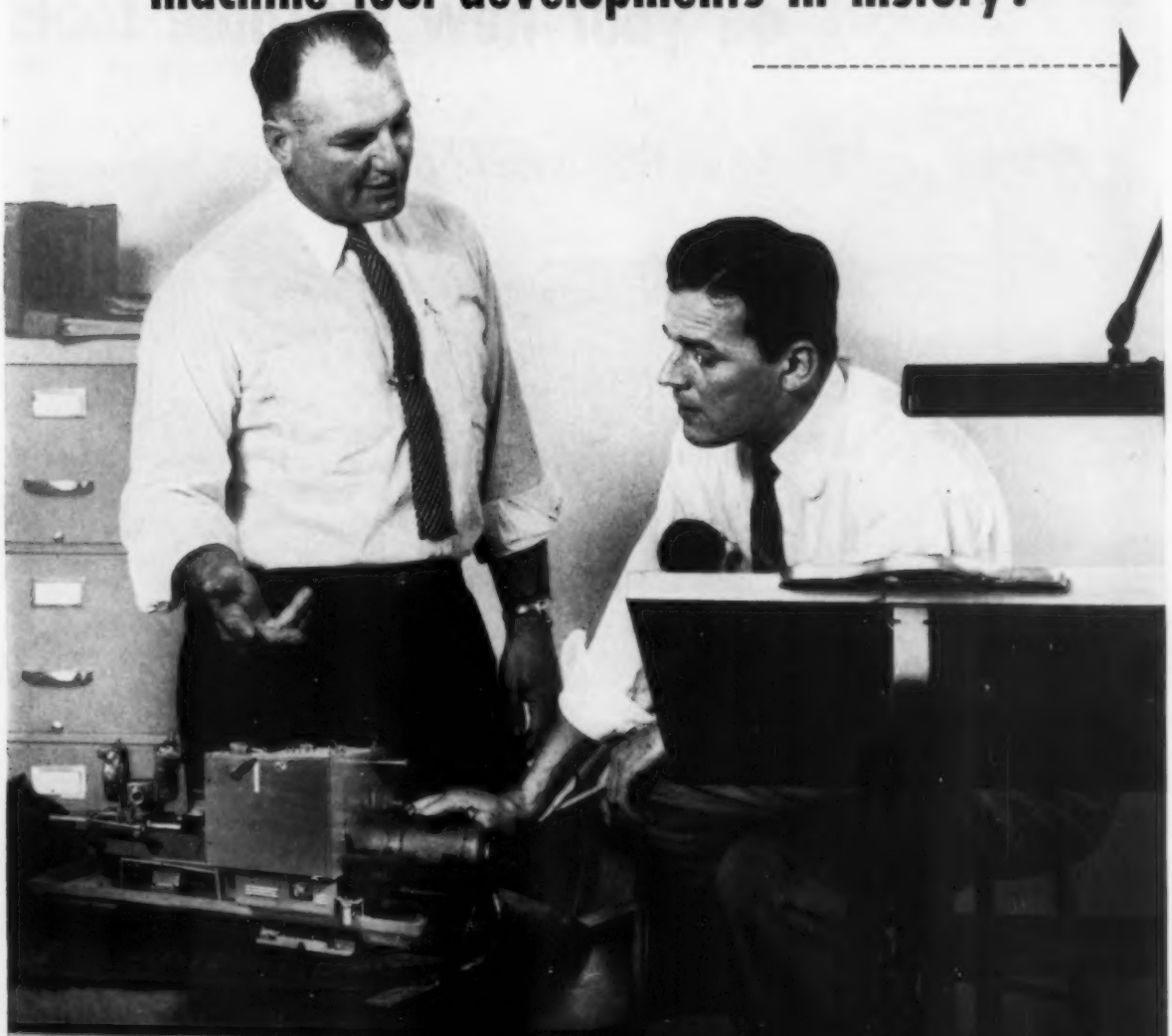
This report was prepared by Armour Research Foundation under Task No. 70923, which is part of Project No. 7060, "System Dynamics Research and Analysis." It summarizes characteristics of devices useful in automatic data recording and reduction systems which are commercially available or are under development. Included are: analog voltage-to-digital converters, shaft-position digitizers, digital plotters, digital-to-analog converters, digital voltmeters, and special tape recorders.

Analog voltage-to-digital converters

(Continued on page 473)

MACHINE TOOL DESIGNERS:

Westinghouse components and services will help you pioneer the greatest machine tool developments in history!



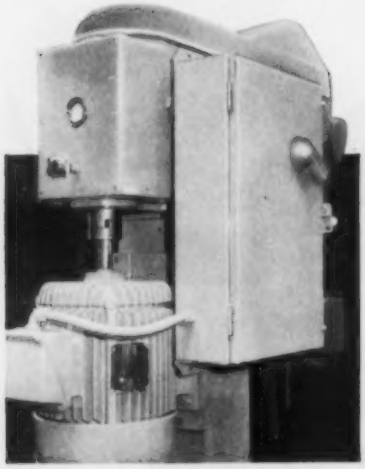
YOU CAN BE SURE... IF IT'S

Westinghouse

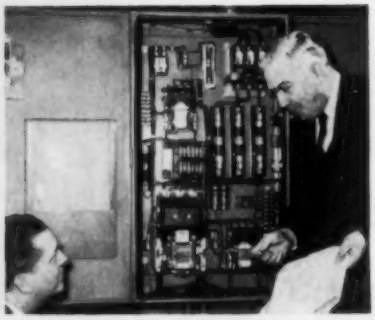
MP-3050-1

NEW DEVELOPMENTS FROM WESTINGHOUSE . . .

Improve drive and control functions on your new machine tools

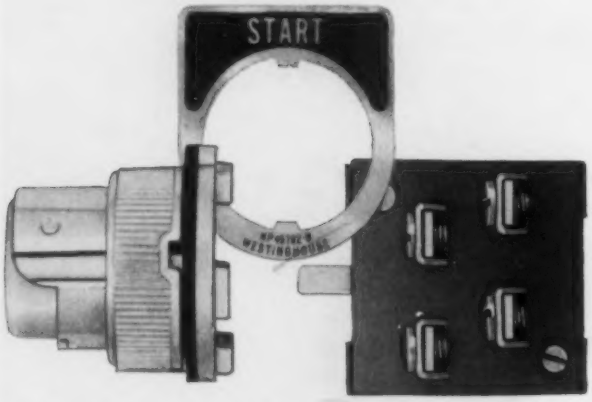


Eighty light-load reversals per minute and no overheating . . . with Westinghouse Life-Line® "A" motors. Reliable performance under severe duty cycles lets you plan greater versatility for machine tools.

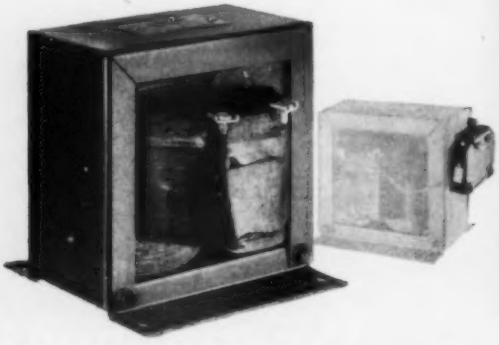


Cushioned start of connected load is assured by Westinghouse magnetic reduced-voltage starters. Add-A-Part feature provides flexibility for design and future change-over.

Cypak control has no moving parts to wear, corrode or jam. Service life is 15 times that of mechanical relays, maintenance and down time virtually eliminated. Cypak systems are compact, light, easy to modify.



Just 38 Westinghouse Oil-Tite* pushbutton components . . . standardized, interchangeable, always available from stock . . . offer up to 1,500,000 pushbutton control arrangements—cut space, inventory needs. *Trade-Mark



Westinghouse machine tool transformers take one-third less space, exceed NEMA regulation standards by 30%. Add-A-Part fuse blocks and breakers extend design selection, reduce transformer inventories.

The growing trend to faster specialized machine tools with more automatic operation makes design of compact, dependable drive and control systems for your products more vital than ever. Westinghouse has recently contributed many significant electrical developments to machinery builders that promise great strides in machine tool progress.

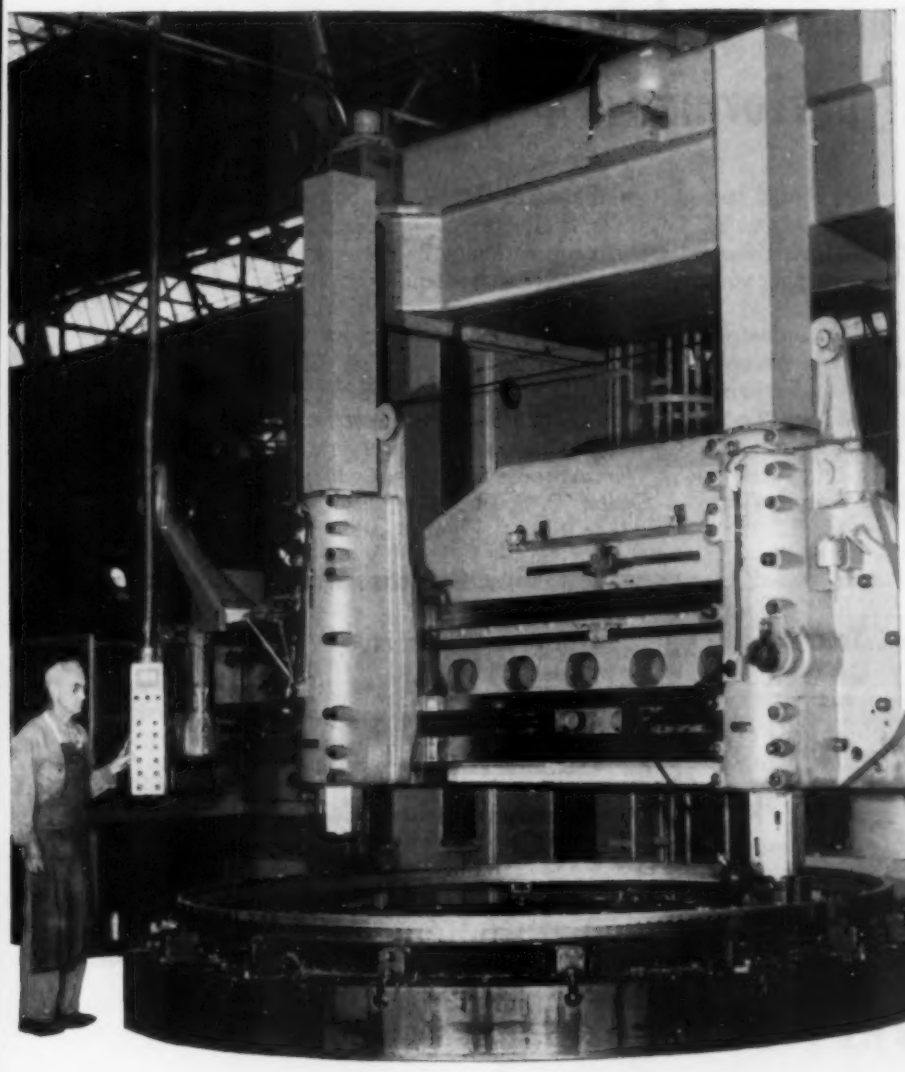
For example, there's Cypak*, a revolutionary development of Westinghouse research for reliable electrical control for machine operations, processes, and coordinated handling of materials. *It has no moving parts* to wear, corrode or jam . . . assuring long life and dependability.

Contactless limit switches, industrial electronic components unsurpassed in performance, improved-design motors, and numerous other product refinements and innovations point to Westinghouse as the electric components supplier for your machine tools.

Developments like these will help you design and build machine tools that better satisfy your customers through increased productivity, reduced inspection and maintenance, and more precise operation. Whatever the function you want performed . . . sensing, transmitting, recording, computing, control, or driving... think of Westinghouse components first.

*Trade-Mark
MP-3050-2

YOU CAN BE SURE... IF IT'S Westinghouse



Versatility of Westinghouse AV Drive pays off in applications like this heavy-duty, 14-foot boring mill. Package drive provides on-the-spot conversion of a-c power supply to d-c for precise speed control over a wide, adjustable speed range.

Westinghouse service and facilities back up product performance

Your local Westinghouse representative should be a member of your machine design team. He is trained to give you the full benefit of Westinghouse engineering and development information in analyzing your machinery electrification problems.

Westinghouse facilities are located in industrial centers from coast to coast. Westinghouse research . . . field engineering service . . . local manufacturing and repair plants . . . renewal parts stocks . . . all have been established to benefit you and your customers.

The Machine Tool Electrification Forum, sponsored annually by Westinghouse during the past 21 years, is an example of Westinghouse participation and cooperation with the machine tool industry. New ideas fostered and exchanged at such meetings help speed machine tool advances.

When you specify components, choose Westinghouse and be *sure*. You get one-supplier responsibility for products of outstanding quality, backed by more than 70 years of electrical experience. And, Westinghouse components help sell your products. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

MP-3050-3

Westinghouse serves these O. E. M. industries

- Air conditioning
- Appliance
- Communications—electronic
- Electric apparatus
- Fan and blower
- Machine tool
- Materials handling
- Panelboard and switchboard
- Prime mover equipment
- Pump and compressor
- Miscellaneous machinery

. . . with these components

- Motors—gearmotors
- Adjustable-speed drives
- Gearing
- Controls—relays—circuit breakers
- Semiconductors
- Cypak
- Magamp* magnetic amplifiers—rectifiers
- Heating elements—thermostats
- Transformers
- Instruments
- DYNAC® magnetic braking

*Trade-Mark

YOU CAN BE SURE... IF IT'S Westinghouse

and shaft-position digitizers are the most important equipments for use in automatic and semi-automatic data-recording facilities. The digital plotter and printer are also necessary components of such a system and the digital-to-analog converter is useful in adapting normally analog indicating equipment to otherwise digital systems. The magnetic tape recorders included in this catalogue are a small part of available tape recorders for recording or reduction system application; the recorders chosen were those which came to the attention of the authors as being not only useful, but new in development. No attempt was made to include magnetic drum or core output-storage units, though the value of these devices in high-sampling rate systems is considerable. Card punching and printing equipment were omitted because these devices are already well known. Part I of this survey dealt with Automatic- Data-Recording Devices.

Principles of Engineering' Heat Transfer

WARREN H. GIEDT, *University of California.* 6 x 9 *in.*, 372 *pp. Published by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J.* $8.25.

Intended as an undergraduate text, this book starts at an elementary level but progresses to fairly advanced concepts of conduction, radiation, and convection. One and two-dimensional steady-state heat transfer by conduction are covered first, followed by two chapters on fluid flow as the basis for later chapters on convective heat transfer. Radiation is covered in two chapters; first, as a physical phenomenon, second, as a means of heat transfer.

Transient and periodic heat transfer chapters conclude the theoretical discussion and a final chapter on heat exchanger calculations provides a practical example for the student.

Silicon Rectifier Handbook

Catalog No. 669, 8½ x 11 *in.*, 36 *pp. Available from Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind.* $.25. *(paper-bound)*

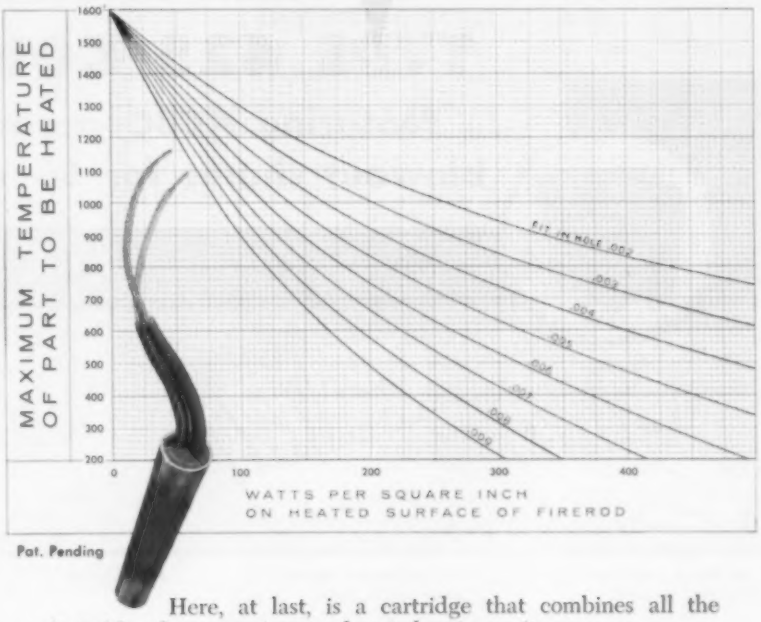
Of recent developments and improvements in the fields of power conversion and semi-conductors, silicon

(Continued on page 476)

here's graphic PROOF of the HIGHER WATTS DENSITY in WATLOW

FIREROD®

CARTRIDGE HEATERS



Pat. Pending

Here, at last, is a cartridge that combines all the desirable advantages in *one* electric heating unit:

HIGH WATT DENSITIES

The *same* wattage in a unit 1/5th the size. Your equipment can be heated with less units or with smaller units.

HIGH TEMPERATURE POTENTIAL

Prolonged heat applications to 1400°F. – and to 1600°F. and higher for short periods.

LONGER CARTRIDGE LIFE

Test units have been operated in open air at 90 watts per sq. inch at 1800°F for periods in excess of 720 continuous hours. Standard cartridge units have a life measured in minutes under this extreme breakdown test.

Think of the new design flexibility – lots of heat in a small space. Units from ⅜" to 12" long; ⅛" and ¼" diameters.

WRITE for informative new BULLETIN #360. Full of convincing facts and figures.

WATLOW ELECTRIC MFG. CO.

SINCE 1922 – DESIGNERS AND MANUFACTURERS OF ELECTRIC HEATING UNITS

1392 FERGUSON AVE.

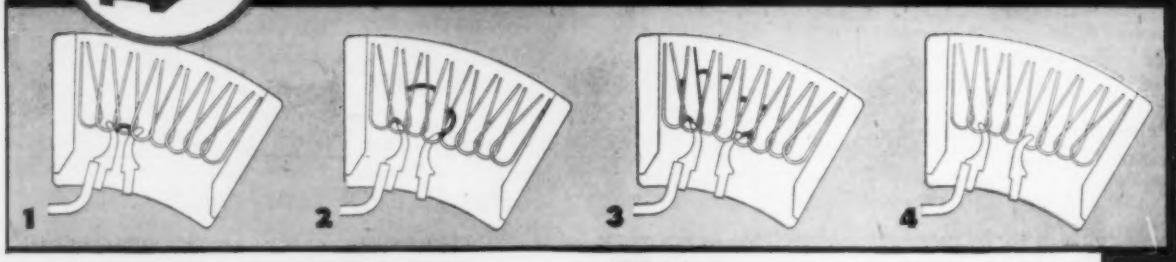
SAINT LOUIS (3), MO.

for fast arc interruption... without blowout coils

ALLIS-CHALMERS

TYPE 425 CONTROL

featuring *ACBO* arc-centering blowout chutes for 50 to 400 hp



1 Arc across contacts as they start to open.

2 Strong blowout action forces arc to center.

3 Arc rupturing.

4 Contacts fully open — arc extinguished.

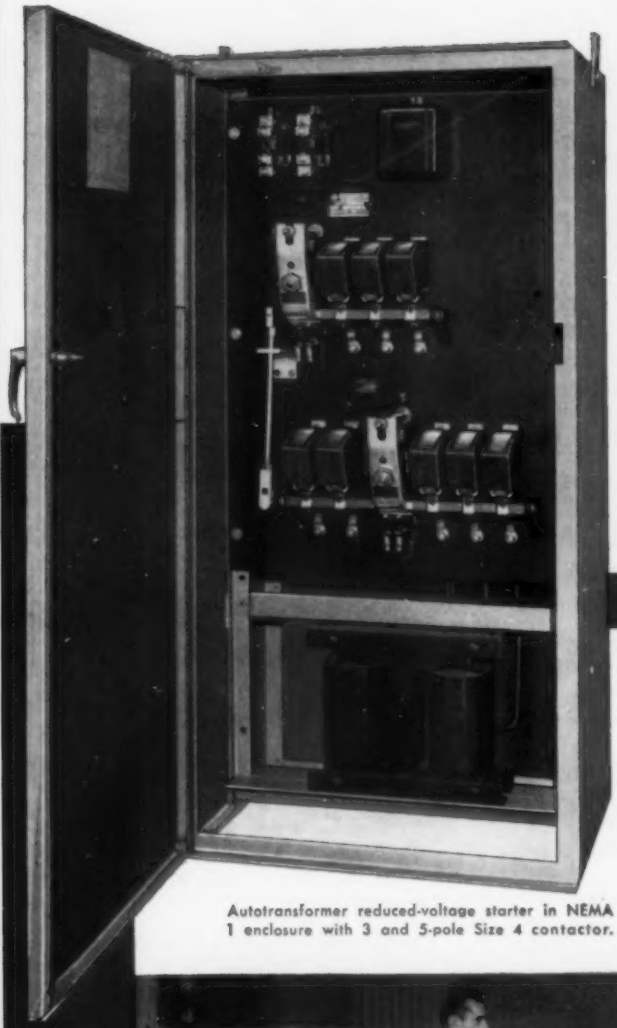
Advanced electrical design

Allis-Chalmers Sizes 4, 5 and 6 Type 425 starters and contactors incorporate the *ACBO* arc chute for much longer contact and chute life . . . for maximum contactor efficiency . . . for improved performance. This unique but simple device utilizes the principles of magnetic action and thermal convection to center, rupture and extinguish the arc — *quickly* . . . without the use of conventional blowout coils.

Simplified mechanical design

- Streamlined clapper-type construction eliminates many parts — permits natural arc rise in arc chute.
- Accessibility simplifies inspection and maintenance.
- Installation is fast and easy. Ample wiring space is provided by *sensible* enclosure dimensions . . . by well-placed concentric knockouts, terminal lugs and conduit hubs. Terminals are clearly marked.

ALLIS-



Autotransformer reduced-voltage starter in NEMA 1 enclosure with 3 and 5-pole Size 4 contactor.

A type for any application

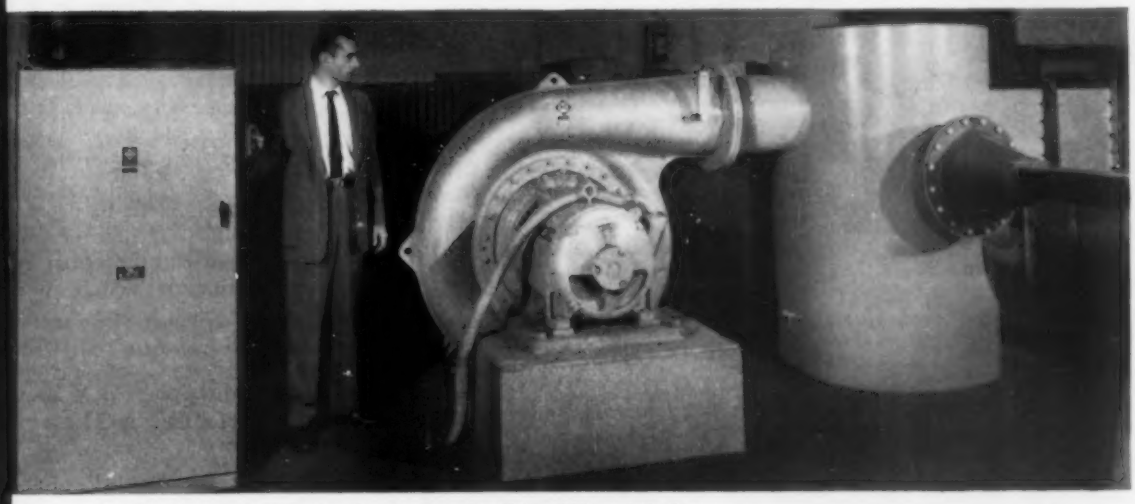
- Across-the-line general purpose starter
- Combination starter with disconnect switch
- Combination starter with circuit breaker
- Reversing starter
- Multi-speed starter
- Autotransformer reduced-voltage starter
- Primary reduced-voltage starter
- Magnetic increment-type starter (part winding)
- Magnetic star-delta starter
- Wound-rotor motor starter
- Synchronous motor starter
- Low voltage group control
- Ac magnetic contactor

Modifications available for applications requiring special features or design.

Engineering help

Allis-Chalmers offers expert engineering and application advice. Product specialists, industry application experts, modern laboratory and testing facilities . . . are all available for coordinated effort to help solve your control problems.

For detailed information on Type 425 control, call your A-C Control Distributor or your local A-C District Office . . . or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis. Ask for Bulletin 14B8615.



Size 4, reduced-voltage autotransformer starter for 50-hp, 3550-rpm induction motor driving turbo-blower. Motor and blower also built by Allis-Chalmers.

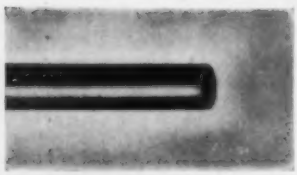
ACBO is an Allis-Chalmers trademark.

CHALMERS

A-5342

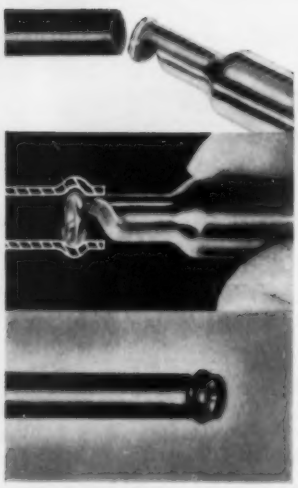
DANCO ANNOUNCES

revolutionary new
TUBE FITTING DESIGN



simple . . . fast . . . versatile . . .
with NO REDUCTION IN I. D . . . .
NO REDUCTION IN FLOW!

Sealed tight, quickly-assembled fittings by Danco present limitless new opportunities in plastics and rubber tube applications.



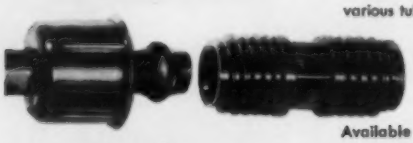
3 simple steps!

1. Cut tube to desired length
2. Slip fitting on tube
3. Insert special non-corrosive ring and tighten connection.

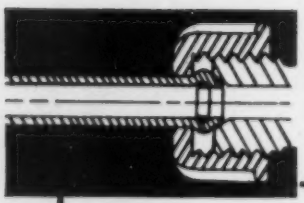
No welding! No threading! No special adhesives! Installation is simple, mechanical, complete in seconds. And it's just as easy to disconnect a Danco fitting.

Here's the most sensational development in tube fittings in the last ten years. The new Danco Fitting has been designed *especially* for flexible tubing . . .
A MODERN FITTING FOR MODERN TUBING.

COMPLETELY MECHANICAL—
With no intricate equipment. Requires only the simple Danco ring-holder and rings (available in a wide range of sizes for various tube diameters.)



DANCO TUBE FITTINGS
Wear-and corrosive-resistance nylon. Available in terminals, tees, 90°, and special fittings designed for specific applications.



FREE APPLICATIONS SURVEY
For more information on the NEW Danco tube fitting, write today outlining requirements. Specify application, please.

DANCO — DANIELSON MANUFACTURING COMPANY, A SUBSIDIARY OF NICHOLSON FILE CO. — DANIELSON, CONN.

Gentlemen: More facts, please.

☐ Descriptive literature Danco Fittings
☐ Have your representative call.

NAME.....
TITLE.....
COMPANY.....
ADDRESS.....
APPLICATION.....
(SPECIFY TUBING USE)

rectifiers have the most promising range of applications. Inherent characteristics of silicon allow junction temperatures in the order of 200 C before the material exhibits intrinsic properties. This extends silicon's operating range beyond that of any other efficient semi-conductor and the excellent thermal range coupled with small size per watt of output power, and high efficiency because of high inverse resistance, make silicon rectifiers applicable where other semi-conductor rectifiers were previously considered impractical.

This handbook covers basic concepts of design and application. It is a brief but comprehensive treatment which includes theory of operation, manufacturing process, electrical and thermal characteristics, mounting, construction and typical applications. Also included are data on currently available types, rectifier design information, and test procedures.

Applied Strength of Materials

ALFRED JENSEN, *University of Washington, Seattle, Wash.* 6 x 9 *in.*, 337 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $5.75.

This simplified approach to strength of materials is intended as a one-semester text to acquaint the student with the properties of various engineering materials, and to teach him how to design various types of structural members and connections commonly found in machines and buildings.

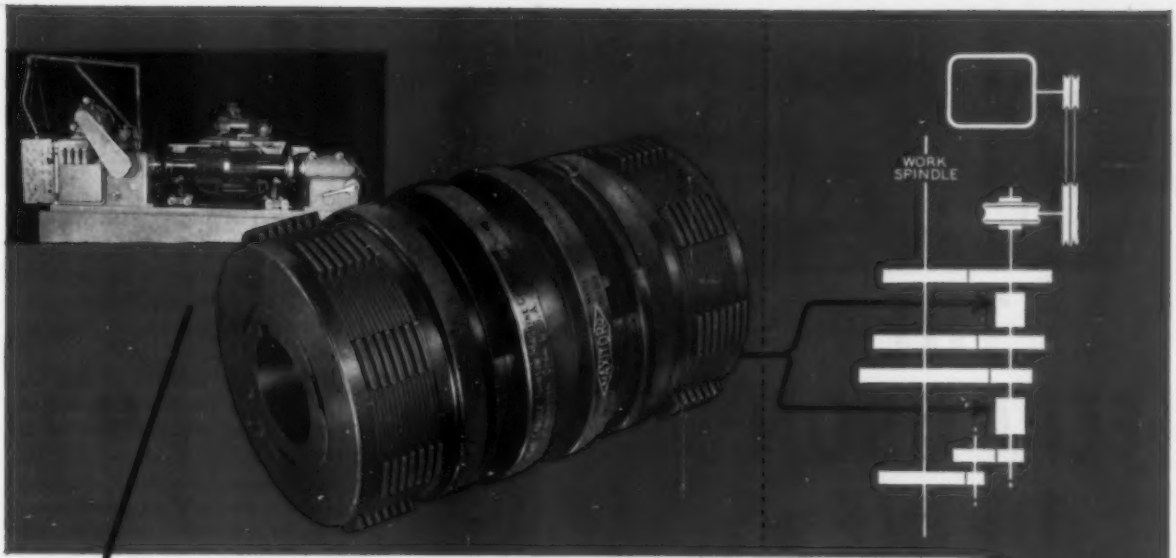
All design formulas have been developed without the use of calculus and are based on explanations of the easily understood relationships of cause and effect, action and reaction.

An Introduction to Junction Transistor Theory

R. D. MIDDLEBROOK, *Asst. Professor in Electrical Engineering at California Institute of Technology.* 6 x 9¼ *in.*, 296 *pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $8.50.

This book is a connecting link between the physical processes in semiconductors and the circuit propertics

(Continued on page 478)



how Maxitorq Floating disc clutches

helped MICHIGAN TOOL design push-button speed and versatility into new "king-size" gear shaver

The two MAXITORQ Double Clutches tucked so compactly into the main-drive gear-box on Michigan Tool's Model 885 Gear Shaver permit simple, positive, finger-tip selection of four speed ranges, infinitely variable, with a low of 1.3 to a high of 166.4 r. p. m. They are an important key to this new machine's outstanding features of versatility, speed, quick change-over, and push-button control.

Machine tool and industrial equipment designers find in MAXITORQ Floating Disc Clutches the essentials of COMPACT design and instant positive engagement and disengagement . . . freedom from drag or heating in neutral and full power transmission . . . that are so important to the success of installations such as these. MAXITORQ Floating Disc Clutch design and *performance* have been PROVED by many years of service under all conditions.

Outstanding advantages of MAXITORQ Floating Disc Clutches for machine tool and equipment drives also include RUGGED SIMPLICITY of all parts . . . MINIMUM EFFORT for engagement and disengagement . . . EASY MANUAL assembly, disassembly and adjustment. Available in a full range of sizes in SINGLE, DOUBLE and AUTOMATIC OVERLOAD RELEASE types.

SCJ57

For full information, write Dept. PE.-5.

THE CARLYLE JOHNSON MACHINE COMPANY

Manchester, Connecticut

DUPONT PRODUCT ENGINEERING NEWS

HIGH SPEED INDEXING

THE FERGUSON DRIVE

Replaces geneva drive...

INCREASES PRODUCTION *UP TO 100%*

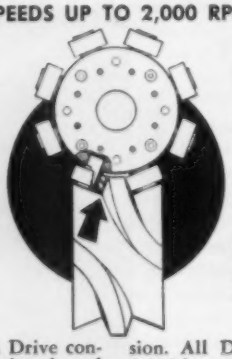
Often the development of improved manufacturing methods is stopped short because the speed-limiting indexing mechanism in the basic machine prevents the full utilization of better automatic tools, feeds and processes.

The Ferguson Drive eliminates this barrier to continued advancement by replacing geneva drives and other obsolete indexing devices and increasing operating speeds as much as 100% . . . in fact, the Ferguson Drive opens an entirely new field in which to improve the efficiency and capacity of production machinery because it operates. . .

. . . AT SPEEDS UP TO 2,000 RPM WITH:

Zero Backlash

Minimum of 8,000 Hours Operation without Maintenance



Precision of .001"

Smooth Starting and Stopping

Components of the Ferguson Drive consist of a precision cut, hardened and ground tool steel cam with a tapered rib and a hub with bearing followers. Two followers remain in contact with the cam rib at all times and are preloaded to assure zero backlash and extreme precision. All Drives are rated for at least 8,000 hours precision operation and may be renewed for a like period by replacing the standard followers. With a modified trapezoid acceleration characteristic, smoothness of indexing is achieved even at highest speeds.

Want to know more about the Ferguson Drive? Send for our Catalog No.107

Get complete information, including load ratings and dimensions of the many standard models; methods for calculating load requirements and data on many types of installations. There's no obligation . . . so write today!

HIGH SPEED INDEXING • STANDARD TRANSFER MACHINES • AUTOMATIC TOOLING

ferguson

FERGUSON MACHINE CORPORATION OF INDIANA

Roller Gear Division, Dept. B-5 • P.O. Box 5841, St. Louis 21, Mo.

of a junction transistor. In this area it is a bridge between the domain of the physicist and that of the engineer. This book provides a continuous development of basic junction-transistor theory, from fundamental physical principles to practical circuit representations. It presents a new practical equivalent circuit which represents the small-signal behavior of a junction transistor over its useful frequency range as an amplifier.

Much of the material offered here appears for the first time in book form. Some of it has appeared only in isolated papers; and some, notably that on equivalent circuit work, originates with the author. The presentation is written from the viewpoint of the electrical engineer, presupposing only an elementary knowledge of electronics, physics and mathematics.

Tool Design

CYRIL DONALDSON and GEORGE H. LE CAIN, *Mechanical Dept., Rochester Institute of Technology* 6¼ x 9¼ *in., 560 pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y. Second edition,* $6.75.

Written as a textbook for a course in tool design, this book develops general methods of tool design by which the student can translate his ideas into practicality. Chapters on punches and dies, theory of cutting tools, jigs and fixtures, and screw machines have been rewritten and expanded in the light of more recent experience. Similarly, the continuous development of

(Continued on page 482)

"Don't be taken in by that—"

DU PONT
Better Things for Better Living through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Dial faces of LUCITE® molded with integral hairline cut production costs

The precision with which Du Pont LUCITE acrylic resin can be fabricated is demonstrated by this hairline molded into one surface of a potentiometer dial face. The hairline is a half-round recess transferred directly from the die. The dial face replaces an assembly having a soldered wire hairline and a glass window, at a saving of $1.80 per unit. The parts made of LUCITE are economical to fabricate and withstand shock.

LUCITE offers outstanding transparency, transmitting about 92% of impinging light. LUCITE also has the ability to "pipe" light. In this instance, the clear LUCITE of the dial face transmits the "darkness" of the encasing black panel to the hairline, so that it is unnecessary to fill the hairline with black paint. The dial faces have been in service for more than two years with satisfactory results.

LUCITE is available in a wide range of sparkling, non-fading colors. It is shatterproof, light in weight, and resistant to weathering and many chemicals. LUCITE is fabricated economically by injection- or compression-molding, or extrusion. Du Pont LUCITE may be able to solve a design problem for you, particularly where high-grade optical qualities are required. Clip the coupon for more information about LUCITE acrylic resin.

This portable potentiometer, employed as a millivolt indicator, is manufactured by Leeds & Northrup Company, Philadelphia, Pennsylvania. Inset shows dial face of Du Pont LUCITE acrylic resin used in the instrument.

Precision molded parts of ZYTEL® can eliminate costly machining operations

"Likwidurn" soap dispenser manufactured by American Dispenser Company, Inc., New York, New York. Replacement of stainless-steel parts in valve assembly with parts of ZYTEL nylon resin afford substantial cost reductions.

Parts of ZYTEL nylon resin feature a high degree of durability, a low coefficient of friction, and good chemical resistance. Products molded of Du Pont ZYTEL are tough and strong, even in thin sections. They have excellent form stability at temperatures as high as 250°F. Cost savings are possible in many applications because components of ZYTEL usually require no secondary finishing. Frequently, a single part molded of Du Pont ZYTEL can replace an entire complex assembly.

The "Likwidurn" soap dispenser, shown above, is designed to deliver a measured amount of liquid soap at each stroke of the valve. Accurate fit of the valve parts is essential to assure proper operation. The valve must also remain unaffected by the concentrated soap solution.

ZYTEL nylon resin was chosen for this application, because it is economical to mass-produce parts injection-molded to close tolerances, which need no further finishing. The use of ZYTEL eliminates machining of the stainless steel, effecting substantial savings in manufacturing costs. In addition, the weight of the unit is reduced.

Evaluate ZYTEL in terms of your own design needs. Property and application data are available without obligation.

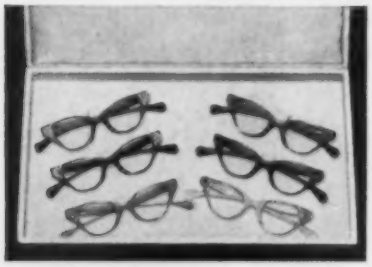
OVER

WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY

DU PONT

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

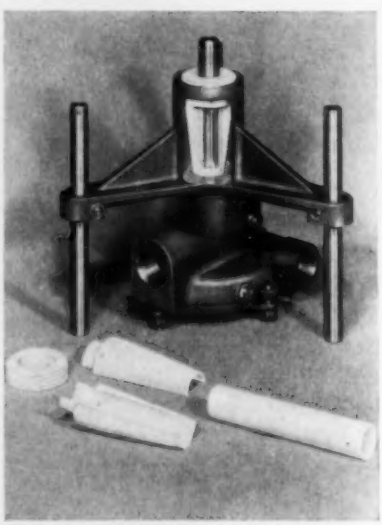


NYLAIRE — frames of ZYTEL® feature exceptional strength . . . attractiveness

Styled eyeglass frames of ZYTEL nylon resin withstand hard usage without breaking, combine attractive design with durability. ZYTEL can be molded in colors, so frames are offered in a selection of 34 permanent shades.

Fashion-conscious purchasers are pleased by smoothness, resiliency, and light weight of ZYTEL. Du Pont ZYTEL is distinguished by its toughness, form stability, and chemical resistance. These eyeglass frames are one interesting application of ZYTEL, which utilizes a number of the properties of this versatile engineering material. The use of ZYTEL may solve a design problem for you. (*Nylaire* eyeglass frames are manufactured by *Limited Editions, Inc., Linden, New Jersey.*)

High-speed bearing of TEFLON® resists corrosive attack, needs no lubrication



Cutaway portion of submersible pump shows bearing assembly of durable TEFLON tetrafluoroethylene resin. Assembly consists of shaft sleeve, tapered bearing, and lock nut. (The pump shown above is manufactured by ECO Engineering Company, Newark, New Jersey.)

A new bearing assembly of TEFLON tetrafluoroethylene resin has greatly broadened the range of applications of this chemical sump pump.

Due to the inherent surface "slipperiness" of TEFLON (kinetic coefficient of friction of only .04), no auxiliary lubrication of the bearing is necessary. Contamination of pharmaceuticals and sensitive materials by contact with lubricants is therefore prevented.

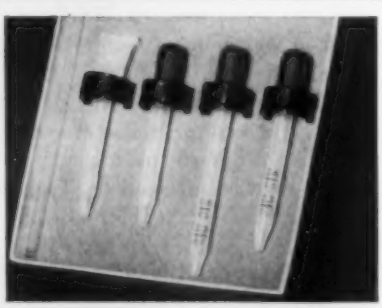
TEFLON is tough and durable. This permits the pump bearing to withstand high radial and tangential stresses at speeds of 3,540 rpm or higher for extended periods of time. The bearing is capable of continuous operation in the presence of product suspensoids and foreign abrasive matter such as tank scale. Bearings of TEFLON permit either chemical or steam sterilization.

Du Pont TEFLON tetrafluoroethylene resin has outstanding chemical inertness. This engineering material is not affected by aqua regia or other acids. Alkalies in any concentration do not react with it. TEFLON is inert to nearly all chemicals and solvents normally used in commercial practice. Exceptions to this include attack by the alkali metals under certain conditions. At elevated temperatures and pressures, halogens and certain halogenated chemicals and solvents may affect TEFLON.

Du Pont TEFLON offers a distinctive combination of mechanical, electrical, and chemical properties. Use of TEFLON has frequently resulted in more efficient, economical, and compact designs. In your applications, too, TEFLON may be the means of economizing on materials and costs or solving a tough design problem. For more details on how TEFLON can help you, clip and mail this coupon.

DROPPERS ARE UNBREAKABLE

Medicine droppers with unbreakable pipettes made of ALATHON® polyethylene resin give a regulated-size droplet. Lines can be printed on the pipette to indicate dosage. Smooth, highly transparent ALATHON reduces danger of injury to delicate tissues from accidental movements. (Made by PharmaPlastics, Inc., Baltimore, Maryland.)



E. I. DU PONT DE NEMOURS & CO. (Inc.), POLYCHEMICALS DEPARTMENT
Room 119, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *ZYTEL;* ☐ *ALATHON;* ☐ *TEFLON;* ☐ *LUCITE. I am interested in evaluating these materials for:*

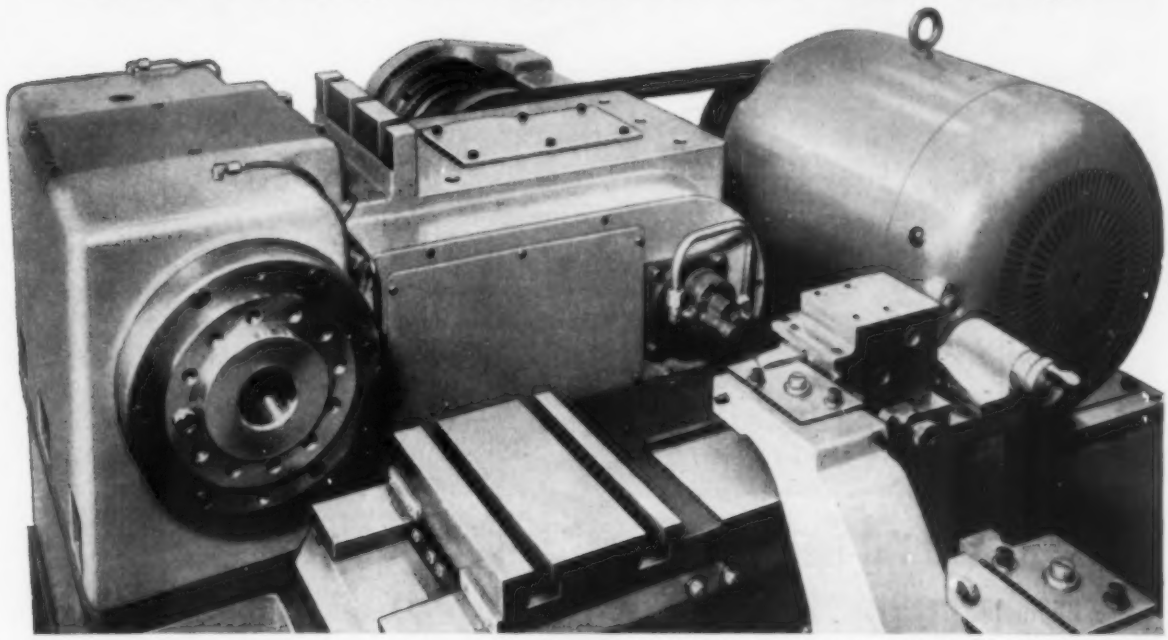
NAME _____ POSITION _____
COMPANY _____
STREET _____
CITY _____ STATE _____
TYPE OF BUSINESS _____

NEED MORE INFORMATION?

"We'll be glad to tell you more about these products at the Design Engineering Show in the New York Coliseum, May 20-23, Booth numbers 1022-1123."

WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY

WAGNER MOTORS mean less down-time for production machinery



This Wagner Type EP Motor is mounted on the base of the Reedmatic Production Lathe.

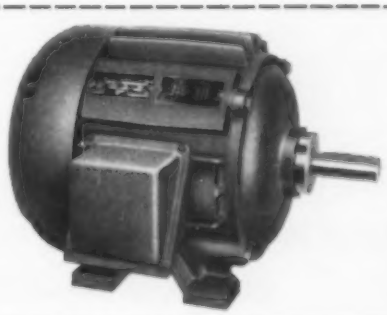
Wagner totally-enclosed fan-cooled motors will give your machine tools the drives they need to give continuous service.

THEY ASSURE LESS DOWN TIME. Wagner totally-enclosed fan-cooled motors are *fully* protected against damage from steel filings, chips, dust, dirt, fumes and moisture. This built-in protection assures freedom from excessive down time caused by motor failure.

THEY REDUCE MAINTENANCE COSTS. Wagner totally-enclosed motors require no maintenance other than periodic lubrication. These motors are designed to run cooler and longer between maintenance periods, but when greasing is necessary, readily accessible lubrication openings permit addition of grease or a complete relubrication.

A Wagner field engineer will be glad to help you design non-stop performance into your production machinery by recommending the motors that best fit your specific needs. Just call the nearest of our 32 branch offices.

This Reed-Prentice tracer controlled automatic production lathe, which turns automobile axles in 30 seconds, is equipped with Wagner Type EP totally-enclosed fan-cooled Motors. These motors are fully described in Bulletin MU-203. Write for your file copy today.



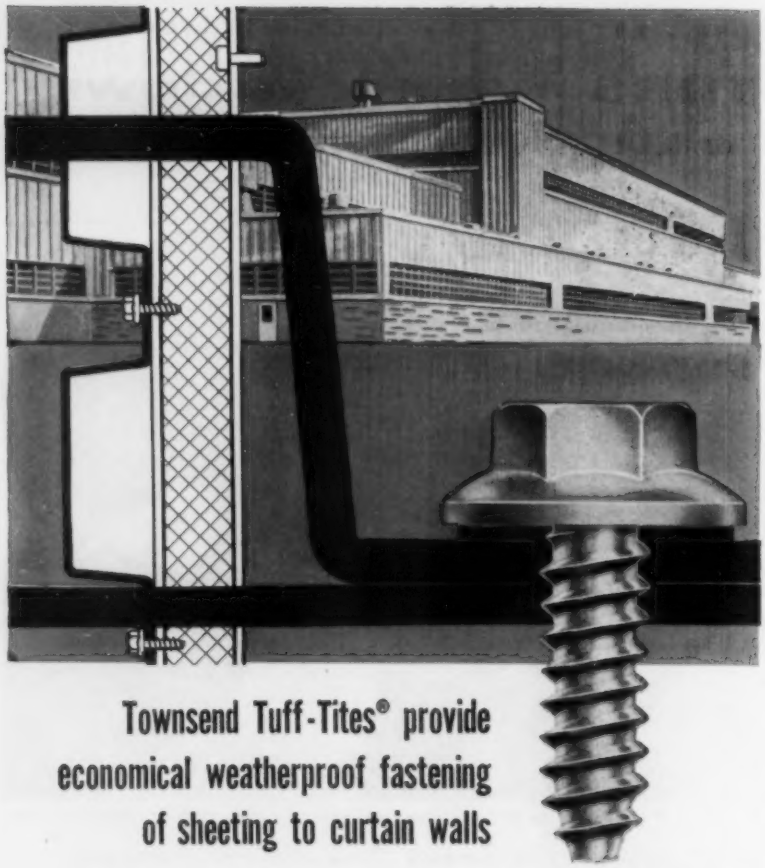
MS7-6

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo., U.S.A.

VISIT US IN BOOTH 522-24 AT THE DESIGN ENGINEERING SHOW IN NEW YORK THIS MONTH.



Townsend Tuff-Tites® provide economical weatherproof fastening of sheeting to curtain walls

Townsend Tuff-Tite fasteners provide weatherproof fastening of exterior sheeting to insulated panels used in curtain wall and roof construction. Leakage is eliminated by the Tuff-Tite's integral undercut hex head and washer construction and by the pre-assembled conical shaped neoprene washers which fill the holes.

An outstanding application of Tuff-Tites in curtain wall construction is the "A" panel made by Elwin G. Smith & Co., Emsworth, Pa. These panels are made with a number of different surfaces and have been installed by Elwin G. Smith on buildings in varying climates from New England to Texas.

Tuff-Tites are available in both stainless and carbon steels in a number of types and lengths. They are equally suitable for crown or valley fastening because of their excellent sealing qualities and may be used with aluminum, galvanized steel, stainless steel, protected metals, fiberglass plastic or asbestos siding and roofing.

For more information on these economical, weatherproof fasteners, write to Townsend Company, P.O. Box 237-A, New Brighton, Pa., asking for Bulletin TL-107a.

See Tuff-Tites Demonstrated At The Design Engineering Show—Booth 1139

The fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Chester Rivet Division • Santa Ana, California

In Canada: *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

new alloys and their application to tool production made a rewriting of the section on tool materials necessary.

These revisions effectively bring the book up to date. While primarily written for the student, the book is valuable for reference to the practicing engineer.

Theory of Vibrations For Engineers

E. B. Cole, *The University of Liverpool.* 5¼ x 8½ *in.*, 359 *pp. Published by Macmillan Co., 60 Fifth Ave., New York 11, N. Y.* $6.

A knowledge of the methods employed for eliminating vibration problems is essential to the modern engineer. In many cases it is possible to predict the likelihood of serious vibrations being set up, and consequently to take steps for their prevention, during the design stage of a machine instead of by costly trial-and-error alterations after assembly.

A wide gap exists between elementary treatment and the recent advance analyses available, and the object of this is to bridge this gap and pave the way for higher study. Only the most elementary knowledge of the calculus is assumed, full explanation of all advanced mathematical processes being given.

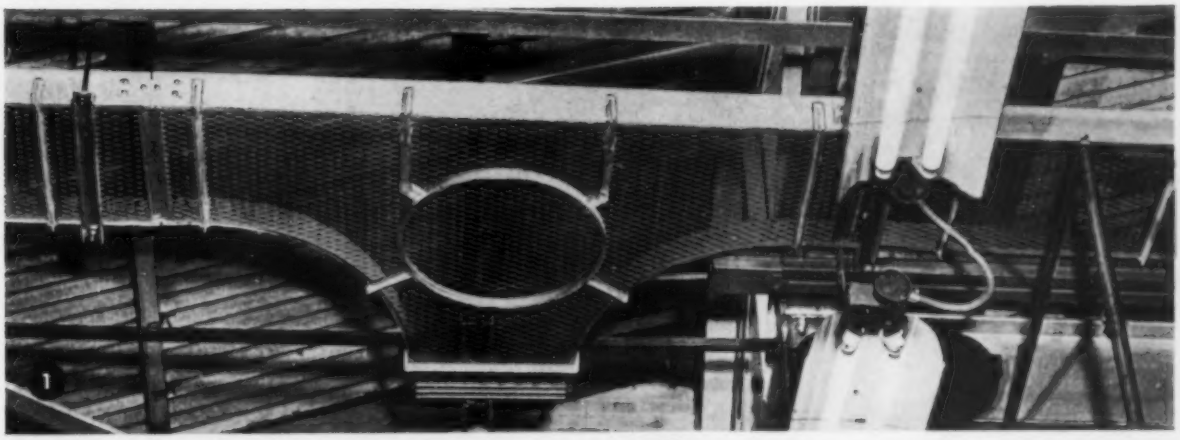
Inventors and Inventions

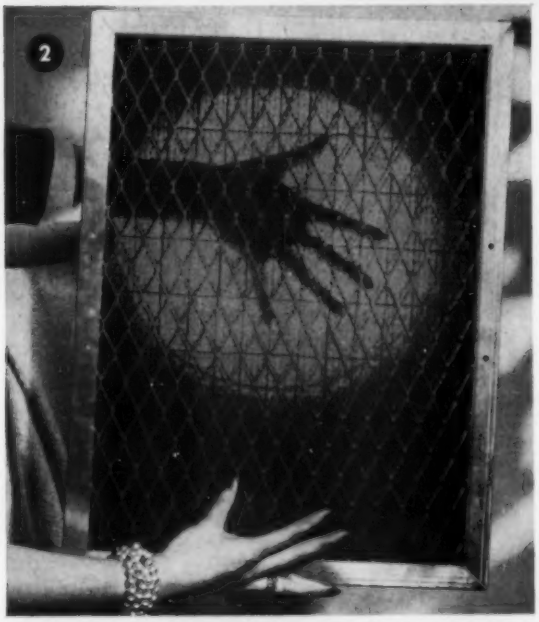
C. D. Tuska, *Dir. of RCA Patent Operations.* 6 x 9 *in.*, 147 *pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $3.75.

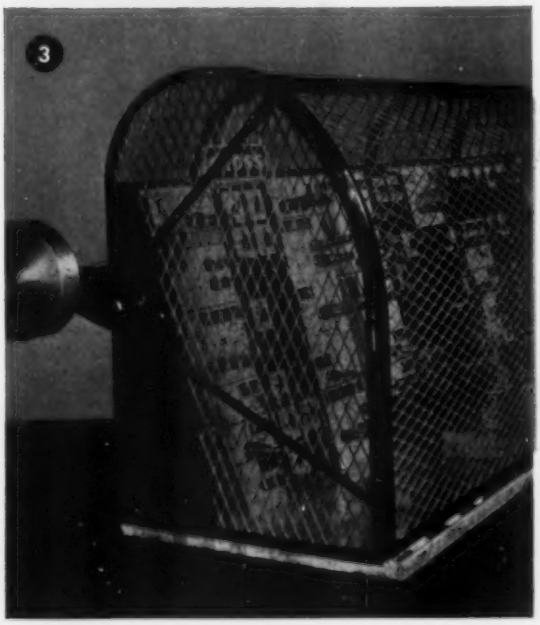
This is not a book on how to get a patent; it is on a level more significant to current problems in product development: how to stimulate inventiveness. The author documents our decreasing inventiveness, presents a thought-provoking analysis of the psychology of creativity, and closes with a discussion of patentability. Authority of the author is implicit in his function—director of RCA patent operations.

"It is a matter of national concern that we find a measurable reduction in the annual rate of scientific creativity, discovery and inventiveness in the United States." What is responsible?

(Continued on page 487)







3 PROBLEMS OF PRODUCT DESIGN...

solved with expanded aluminum

1. High strength, low weight and economy for cable basket—a product of Husky Products, Inc., Cincinnati, O.

2. Corrosion-resistant grille for permanent heating or air-conditioning unit filter—made by Hadley Products Co., Inc., Marietta, O.

3. Strong, open-mesh guard for control and tool panel —Cross Company, Detroit, Mich.

Many products like these have proved successful because their designers took advantage of the valuable properties of Penmetal expanded aluminum.

Up to 80% lighter per square foot than the original sheet, yet fully as strong, Penmetal expanded aluminum can help you design lighter-weight products that will last longer. Its corrosion resistance means durability; sustained clean appearance. Its open mesh permits free passage of light, air and water. What's more, this handsome mesh is easy to weld and surprisingly low in cost.

Products designed in Penmetal expanded aluminum are improved products – products that find better sales acceptance. Want to know more? Send for folder 507-EM. No cost or obligation.

PENN METAL COMPANY, INC.

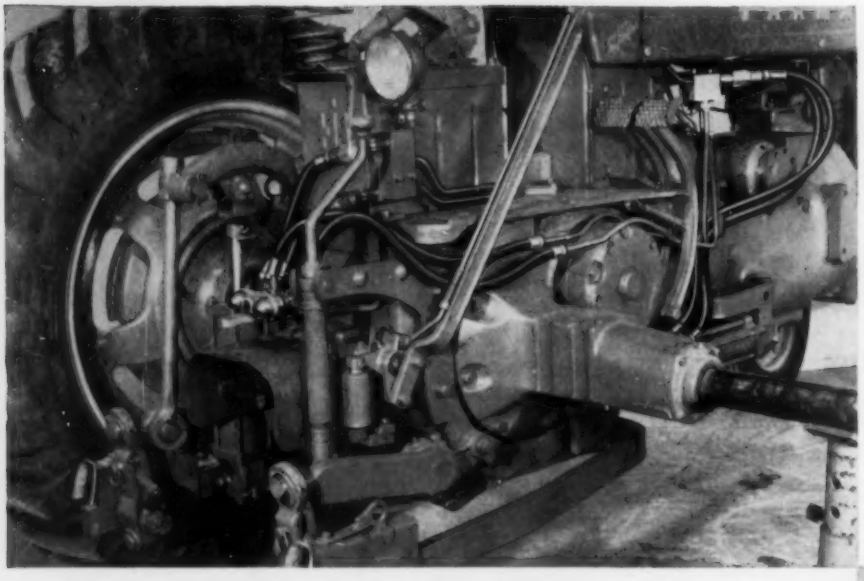
General Sales Office: 40 Central Street, Boston 9, Mass.

Plant: Parkersburg, W. Va.

District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Detroit, St. Louis, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg

Penmetal

PM-142



INTERNATIONAL HARVESTER'S McCORMICK FARMALL 400 Tractor controls every implement action hydraulically through its famous Hydra-Touch hydraulic system. Individual, closely grouped levers permit independent or unison control of cylinders.

HYDRAULIC POWER . . . DELIVERED THROUGH

Eastman

HYDRAULIC HOSE ASSEMBLIES . . .

Most competitive Farm Implement Sales Feature

HYDRAULIC POWER probably contributed more to the usefulness, efficiency, and easy operation of farm tractors than any other modern engineering development. Farmers appreciate hydraulic advantages so much that they have become one of the *most competitive features in implement and tractor sales promotion.*

EASTMAN MANUFACTURING COMPANY is proud to have among its many agricultural users the International Harvester Company—dating back to the first McCormick Reaper—in 1831. Eastman—*first in the field* of Hydraulic Hose Assemblies—lists many other agricultural implement manufacturers among its users: J. I. Case, Allis-Chalmers, Massey-Harris-Ferguson, Inc., Minneapolis-Moline, Farmhand, Avco, and others.

IMPROVE THE COMPETITIVE POSITION OF YOUR PRODUCTS with Hydraulic Power—delivered through Eastman Hydraulic Hose Assemblies. Always specify Eastman: First in exclusive engineering advantages and design! First in materials and workmanship! *First in the field* of Hydraulic Hose Assemblies!

WRITE **Send your specifications and blueprints for our original equipment quotations.**

HYDRAULIC POWER controls plow penetration and depth automatically, lifting and locking in traveling position.

HYDRAULIC POWER controls angle and depth of disc penetration on International Fast-Hitch Bush and Bog Harrow.

HYDRAULIC POWER enables Farmall 200 Hydra-Creeper to travel 1/5 to 1 mile per hour for transplanting.

HYDRAULIC POWER permits raising right, left, or rear cultivator gangs separately, together, or any combination.

Eastman

first in the field

MANUFACTURING COMPANY

Dept. PE-5, Manitowoc, Wis.

FREE! YOUR NEW ACTUATOR and SPLINE "PROBLEM SOLVER"!

New 1957 Engineering Data Book from World's Largest Producers of Ball/Bearing Screws and Splines

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Design Data • Sample Problems, etc.

SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require ⅔ LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +250° F. Two types: precision-ground or commercial rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 10 ft. long.

Visit Booth 122 at Design Engineering Show, May 20-23—New York City

Saginaw ball bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND FOR YOUR FREE COPY TODAY

or see our section in Sweet's Product Design File

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 1J, Saginaw, Michigan

Please send 1957 engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

You realize more

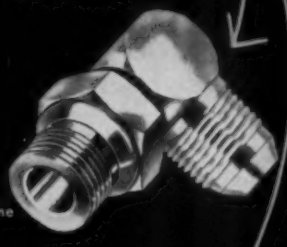
profits

when using L & L's new hydraulic fittings

PROFITS

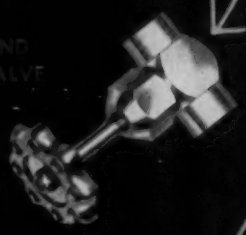
"CN"

- Will stop hydraulic fluid leakage
- Will reduce maintenance . . . assembly time



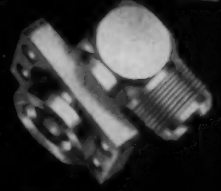
METERING AND SHUT-OFF VALVE

- Rated for 5000 psi pressures
- Choice of outlets
- Simple maintenance



FLANGE FITTING

- Designed for quick installation
- Eliminates pipe thread connections
- Choice of wide selection of outlets



Other outstanding features:

"CN"

- Eliminates stress in valves, elbows and tees
- Can be positioned 405°
- No need for sealing compounds
- Excellent resistance to vibration
- Hex sizes are small to permit close openings for valves and other component parts

Metering and Shut-off Valve

- Stainless Steel stem
- Adaptable to straight or angle valves with male pipe, female pipe or tube connections
- O-ring only replacement part needed
- Available in sizes—⅛" to ¾"

Flange

- Adaptable to solid and swivel tube, pipe or weld connections
- Can couple together to make unions or clusters

All fittings available in a wide range of shapes, sizes

Write for booklet, "How you Profit with L & L" . . . describing the savings you realize when using L & L fittings.

Member of NFPA

L & L MANUFACTURING COMPANY

Dept. P-5, 8000 E. Nine Mile Rd., Van Dyke, Michigan

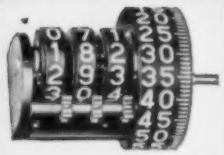
See the L & L exhibit, Design Engineering Show Booth 231

PRODUCT INFORMATION HEADQUARTERS

where you can always find a source of supply for any material or product you need!

THOMAS REGISTER

461 EIGHTH AVE., NEW YORK 1, N. Y.

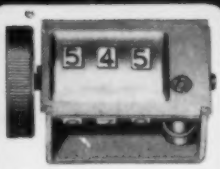


"Read-out" indicator for Loran Instrument. Registers to 50,000 increments per minute.

"Y" Rotary Counter used in navigating instruments.

DURANT *Specials*

For RADAR • ELECTRONIC • INSTRUMENT Applications



Special counter for Tape Recorder to indicate position of tape passing through recorder.

Special high speed Y-type for Goniometer application.

Send for Literature

DURANT MANUFACTURING CO.

1938 N. Buffum St. Milwaukee 1, Wis. — 38 Thurbers Ave. Providence 5, R.I.

Representatives in Principal Cities

PRODUCTIMETERS

SINCE 1879 *Count Everything*

The author examines environment, education, age and sex of inventors, and the psychology of invention.

Environment is examined statistically for the effect of climate, concentration of industry and professional society membership. His conclusion is quoted from a paper published long ago (in 1926), "As a stimulus to invention it is evident . . . that contact with other inventors takes a prominent place."

Education is held to be a deterrent to invention at times. Tendency to develop routine minds in factory-like operation in overcrowded schools is held as hardly conducive to development of pioneers. While the total population is growing the scientific and engineering group is smaller percentagewise than it was 30 years ago.

Psychology of invention is examined from several aspects, ranging from "flash of genius" to logical progression from need to mental conception. Author's conclusion is against existence of a universal psychology of creativity.

For those responsible for patent productivity in their own organizations, the several chapters on methods of inventing and teaching creativeness will probably be of most value. Ten different methods are evaluated and supported by examples. Closing chapters discuss patentability and marketing of inventions. An appendix includes summaries of several patent cases referred to previously and an index.

Ordinary Non-Linear Differential Equations

N. W. McLachlan, *University of Washington.* 6 x 9¼ *in.*, 271 *pp. Published by Oxford University Press,* 114 *Fifth Ave., New York* 11, *N. Y.* $8.80.

This text has been written to provide engineers and physicists with a practical introduction to the subject of non-linear differential equations and to give representative applications in engineering and physics. The text is confined chiefly to the presentation of various analytical methods employed in the solution of important technical problems. Accordingly, the book is not an analytical treatise with technical applications. It aims to show

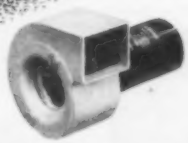
(Continued on page 489)

HEART of your miniaturization program

the EAD 1" MOTOR

Here is EAD's outstanding contribution to the miniaturization program . . . a one-inch diameter, 400 cycle precision motor, engineered for long life and high efficiency. Where minimum size and weight are essential, use this versatile unit. Modifications include high ambient and high altitude versions as well as low voltage designs.

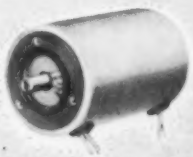
MINIATURE TUBE AXIAL BLOWERS
For efficient cooling and air change in small electronic equipment. Driven by EAD's 1" dia. motor. No brushes, no arcing, no interference.



SUBMINIATURE CENTRIFUGAL BLOWERS
For spot cooling. Moves 9 CFM at 1.35 S.P. Powered by EAD's 1" dia. motor.

MINIATURE RING MOUNTED FANS
For peak performance, compactness, dependability. Blade dia. small as 2" — air del. greater than many heavier blowers. Uses EAD's 1" dia. motor.

MINIATURE GEAR MOTORS
Servo, synchronous or induction units, primarily for 400 cycle and var. freq. operation. Gear ratios up to 10,000 to 1. Basic types use EAD's 1" dia. motor.



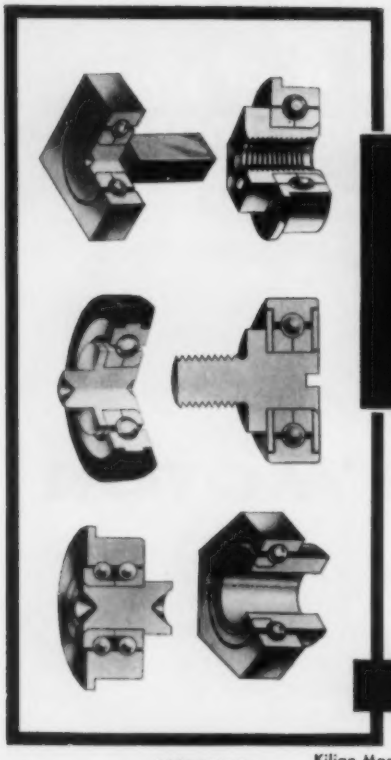
MINIATURE SINE WAVE ALTERNATORS
For very pure sine wave voltage, high power output. Low distortion, light weight, permanent magnet fields. Frame sizes begin with 1" diameters.

Complete specifications available on request.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

381 Central Ave., Dover, New Hampshire



UNGROUND BALL BEARINGS

For All Industries

KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities ***Catalog on Request***

KILIAN MANUFACTURING CORP.

SYRACUSE, NEW YORK, U. S. A.

ASSOCIATED COMPANIES:
Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

Phil Coffer,
President of C & H Supply Co., Manufacturers of Metal-Cals

Phil Coffer says **HERE'S WHAT**

Metal-Cal

CAN DO FOR YOU

METAL-CALS TELL YOUR STORY...

Metal-Cals have many uses on many different products. On some they identify brand names, sometimes they give directions, specifications, warnings, serial numbers. On all products they put your name proudly before the public.

...SELL YOUR PRODUCT

Metal-Cal's deep, rich colors on shiny or matte aluminum finish mean sales. Eye-appealing and attractive, Metal-Cals supplement and contribute to good product design.

...WEAR FOREVER

Coin test (scraping a coin over surface of a Metal-Cal) shows permanence of its etched design. Hard wear or long shelf life on any product will not destroy this permanent beauty.

Send this coupon for free sample and brochure today!
METAL-CAL manufactured by C & H Supply Co.
415 E. Beach Ave.,
Inglewood 3, California • Dept. PE

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE__ STATE_____

U.S. Patent 2,769,265

ARENS

Compact Control

For Remote operation of Dampers, Vents and Valves

Easy to install, low cost sector gear and pinion device with wire flexible control. Converts rotary motion to linear push-pull. 1½" travel. Occupies only 1¾" x 1¼" panel area. Requires only one nut for mounting.

Write For Information

ARENS CONTROLS, INC.
2013 Greenleaf Street
Evanston, Illinois

how certain types of non-linear problems may be solved, and how experimental results may be interpreted by aid of non-linear analysis. Much work involving non-linear partial differential equations has been done in fluid mechanics, plasticity and shock waves. The physical and analytical aspects are inseparable and more than one treatise would be needed to do justice to these subjects. Accordingly, the present text has been confined to ordinary non-linear differential equations. Appendix I has been included on account of the importance of the derived formulae in loudspeaker design. A method of using Mathieu's equation as a stability criterion of the solutions of non-linear equations is outlined in Appendix II.

In this new revised edition, the following have been added: Derivation of non-linear differential equations satisfied by Jacobian elliptic functions. A new version of the stability problems of the synchronous motor. A chapter on fluid flow in two dimensions. More problems (with answers) covering most of the text.

Silicone Rubber

F. L. KILBOURNE, JR., A. S. KIDWELL, T. S. MORONEY. 8½ x 11 *in.*, 48 *pp. Published by Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.*; $1.

The booklet, including 38 graphs and figures, reprints three papers given by chemists of Connecticut Hard Rubber Co. at recent symposiums held in six aircraft centers across the country. The papers discuss the basic chemistry, the properties due to this chemistry, and the considerations and compromises involved in compounding silicone rubber for fabrication.

Bearing Design and Application

DONALD F. WILCOCK and E. RICHARD BOOSER, *General Electric Co.* 6 x 9½ *in.*, 470 *pp. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $12.50.

A practical guidebook for the machine designer in selecting and designing bearings, with emphasis on selec-

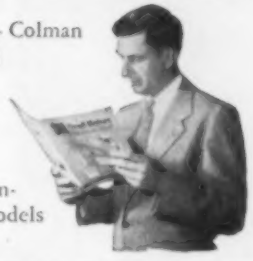
(Continued on page 491)

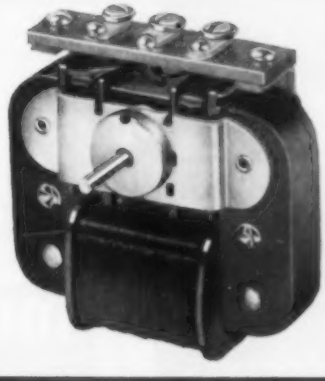
THE MARK OF QUALITY
BARBER COLMAN

Small Motors

condensed catalog helps select exact motor needed

Get this helpful catalog of Barber-Colman a-c shaded pole motors. Designed for applications requiring long life, rugged construction, these quality motors with high starting torque, low-inertia rotors provide quick, positive starting under adverse conditions. Various models of the four types shown below.





REVERSIBLE MOTORS

Adaptable to a variety of control circuits to meet many different requirements demanding a compact and powerful fast-reversing motor. Widely used for servo-mechanisms, remote switching and positioning devices, voltage regulators, pen drives. Available with gear trains, open or enclosed, in wide range of ratios. Low-inertia rotors permitting rapid reversing and follow-up make these motors ideal for many electronic control circuits.

UNIDIRECTIONAL

For driving pumps, projectors, blowers and fans for refrigerators, gear trains for vending and office machines, etc.

SYNCHRONOUS

For chart drives, timers, microfilm cameras, oscillographs, and similar applications.

GEARED

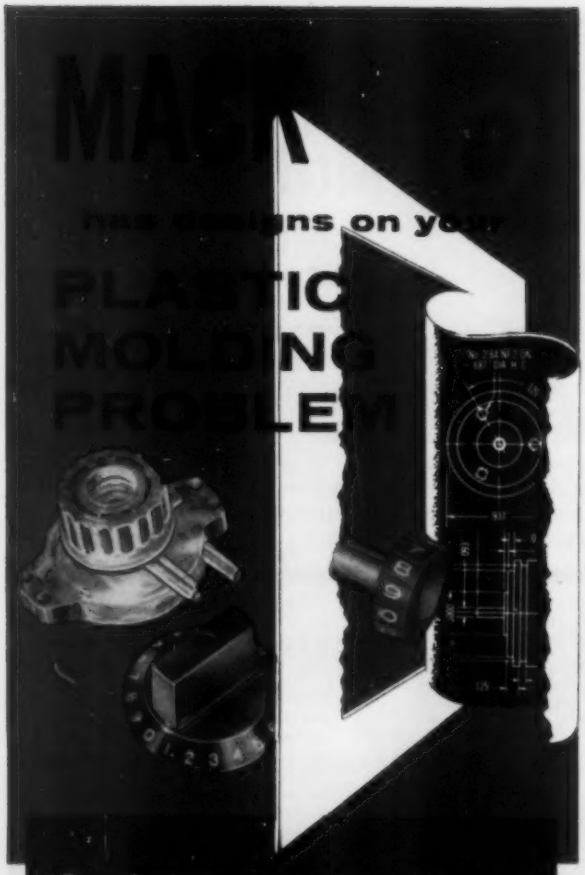
For vending and office machines, rotisseries, TV tuners, program switches, etc. Model shown for overhanging loads.

the complete line of Barber-Colman motors includes unidirectional, synchronous, and reversible motors — up to 1/20 hp. With and without reduction gearing — open or enclosed types. Expert engineering service available to help you get the exact motor for your application. Write today for your free copy of Catalog F-4271-7.

BARBER-COLMAN COMPANY

Dept. P, 1212 Rock Street, Rockford, Illinois.

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls • Air Distribution Products
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery



From Designing to Final Inspection... Over 35 Years of Specialization Assures the Quality of Your Plastic Components

Mack Custom Molding Service

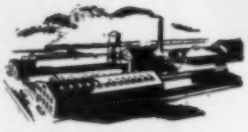
Includes the facilities of three completely equipped plants. Mack design and production engineers are familiar with the problems involved in molding intricate precision industrial parts and functional components for consumer products.

From Blueprint to Delivery

Mack will work with you from the planning stage right through to final delivery. For assistance on specific requirements, just call or write: Mack Molding Company, Inc., Wayne, New Jersey.

Serving Industry for Over 35 Years

Three plants to help with your plastic problems:



• WAYNE, NEW JERSEY

• ARLINGTON, VERMONT

• WATERLOO, P.Q., CANADA

MACK Molded Excellence

PERFORMANCE IS THE PAYOFF!

That's why Bendix Electric Fuel Pump Sales are Zooming

There's no substitute for on-the-job performance. That's why people who have tried all the others always come back to the Bendix* Electric Fuel Pump when they need "must do" performance. The Bendix pump has passed all the tests. Under military supervision, it proved itself at 114° Fahrenheit as well as at 76° below zero. No other pump *anywhere near its price class* could make the grade. The Bendix Electric Fuel Pump is easy to install and service, delivers more gallons per hour—and *positively eliminates vapor lock*. It's the best fuel pump built.

*REG. U.S. PAT. OFF.

Bendix

ELECTRIC FUEL PUMP

BENDIX AVIATION CORP. (Eclipse Machine Div.), Elmira, N. Y.

MARSH *Mastergauge*

The gauge that has everything!

- **LEAK-PROOF ONE-PIECE CONSTRUCTION** . . . bourdon tube fused to socket and tip by exclusive "Conoweld" process.
- **STURDY "MARSHALLOY" CASE** . . . formed of boiler-plate-thickness steel, copper clad inside and outside to give it the corrosion resistance of solid copper. It's one third lighter, but four times stronger than cast iron.
- **PRECISION "MASTERGAUGE" MOVEMENT** . . . with such exclusive features as the coined sector gear.
- **AVAILABLE WITH STAINLESS TUBE AND SOCKET** . . . choice of stainless steels and alloys for all corrosive conditions.
- **WITH "RECALIBRATOR"** . . . quickest and best way to keep a gauge accurate.

These features are combined only in "Mastergauge", standard bearer for the broad line of Marsh Gauges . . . each the best of its kind. Ask for data.

MARSH "THE STANDARD OF ACCURACY"

MARSH INSTRUMENT CO., *Sales Affiliate of Jas. P. Marsh Corp.*, **Dept. 39, Skokie, Ill.**
Marsh Instrument and Valve Co. (Canada) Ltd. 8407 103rd St., Edmonton, Alberta.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas.

tion and calculation methods for integrating the bearing design, bearing material and lubricant into a workable unit.

Among the subjects covered are analysis of load capacity, speed, temperature, dimensional tolerance and lubrication factors in selecting ball and roller bearings; combination of the latest digital computer analysis with bearing material and lubricant selection in hydrodynamic journal and thrust bearings; reciprocating bearing design methods for automotive and diesel use; and lubrication system designs. Included are systematic trouble-shooting techniques for analyzing and eliminating difficulties.

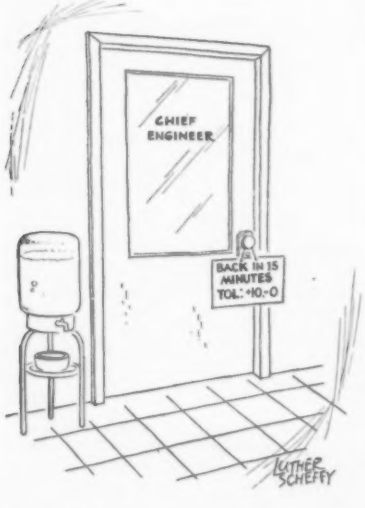
Frequent numerical examples help give a comprehensive picture of the factors entering bearing design and application problems in almost all types of industrial equipment: turbine, motor, automotive, appliance, aircraft and military units.

Research and Development In The Corporation

9 x 11½ *in.*, 93 *pp. Published by American Institute of Management, 125 E. 38 St., New York 16, N. Y.* $12.

This study was originally prepared for the President's Council of the American Institute of Management to provide a method of evaluating the effectiveness of a company's research program. Aimed at the management

(Continued on page 495)



This rotary switch component for an electric range proved to be a delayed-action saboteur. The beryllium copper from which it was formed was so hard that over a period of time it scratched and gouged the phenolic cams actuating the switch—to the point where the switch would soon become inoperative, causing customer complaints and damaging the manufacturer's reputation.

A specially-produced phosphor bronze alloy from Miller provided a quick and painless solution. Miller experts were able to recommend and produce a metal that retained the high degree of spring tension necessary for dependable operation—yet soft enough to protect the cams from damage. And, as an *extra* benefit, the manufacturer also found that it formed more easily—with far fewer rejects.

Miller *specializes* in the expert production of quality phosphor bronze—in strip, coiled and flat lengths—tailored to your specific needs. Remember: at Miller, Phosphor Bronze is the main line—*not* a sideline.

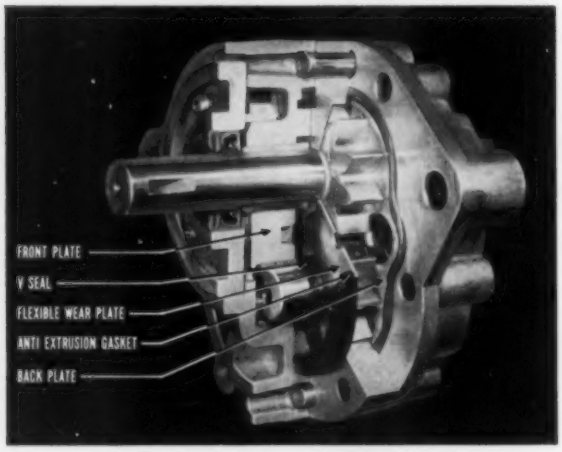
miller
SINCE 1849

THE MILLER COMPANY • MERIDEN, CONN.
ROLLING MILL DIVISION
America's Quality Phosphor Bronze

(Advertisement)

Unique Design Achieves High Gear Pump Efficiency

The gear pump has long been recognized as one of the simplest and most dependable pumping mechanisms available. However, at high pressures it was limited because internal leakage lowered the volumetric efficiency making it necessary for engineers to specify other, more expensive and often less reliable, types of pumps.



Cutaway view showing the internal design of the Cessna pump. The pump is recommended for pressures up to 2,000 PSI, continuous operation.

Since most of the leakage in a gear pump occurs between the gear ends and end plates, especially in the area where the gears mesh, it is obvious that if the clearance between the gear ends and the end plates could be kept near zero at all times, the pump efficiency would be greatly improved. This condition is successfully achieved by a flexible, pressure compensated wear plate featured in a pump developed by our engineers.

The wear plate, made of a steel backed bearing material, forms one wall of the gear chamber with the bearing material next to the gears. A narrow space between the wear plate and the front plate is divided into radially divided compartments by a molded synthetic rubber seal with a "V" cross section. This seal fits with the open part of the "V" down into a corresponding groove pattern in the front plate. An anti-extrusion gasket of a harder material fits into the same groove pattern being sandwiched between the "V" seal and the flexible wear plate.

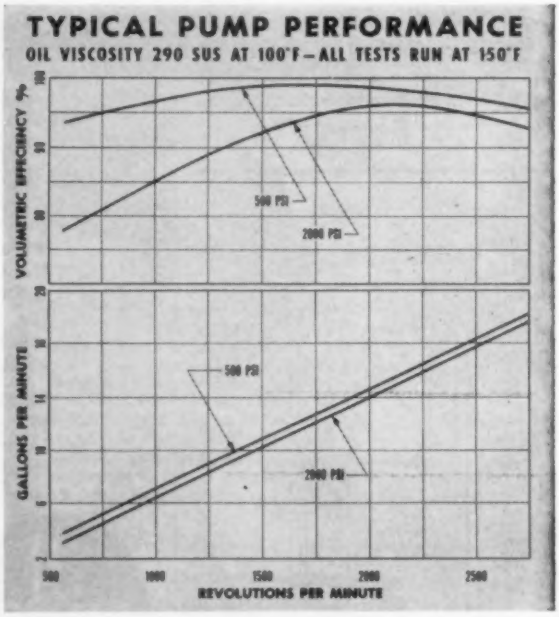
In operation, pressure from the output area of the pump is directed behind the "V" seal pushing it and the anti-extrusion gasket against the wear plate forming the several compartments. Each compartment is connected to the gear chamber by a small hole in the wear plate, the exact pressure within each compartment being determined by the angular position of the small hole within the compartment.

By carefully locating these holes, the pressures in the compartments are such that, together with the force behind the "V" seal, there is just enough net force on the wear plate to deflect it snugly and evenly against the gears and, at the same time, hold the opposite gear ends in contact with the lapped surface of the back plate. Thus, the clearance on either end of the gear is never more than necessary for lubrication, regardless of pressure deflection, thermal expansion, or wear.

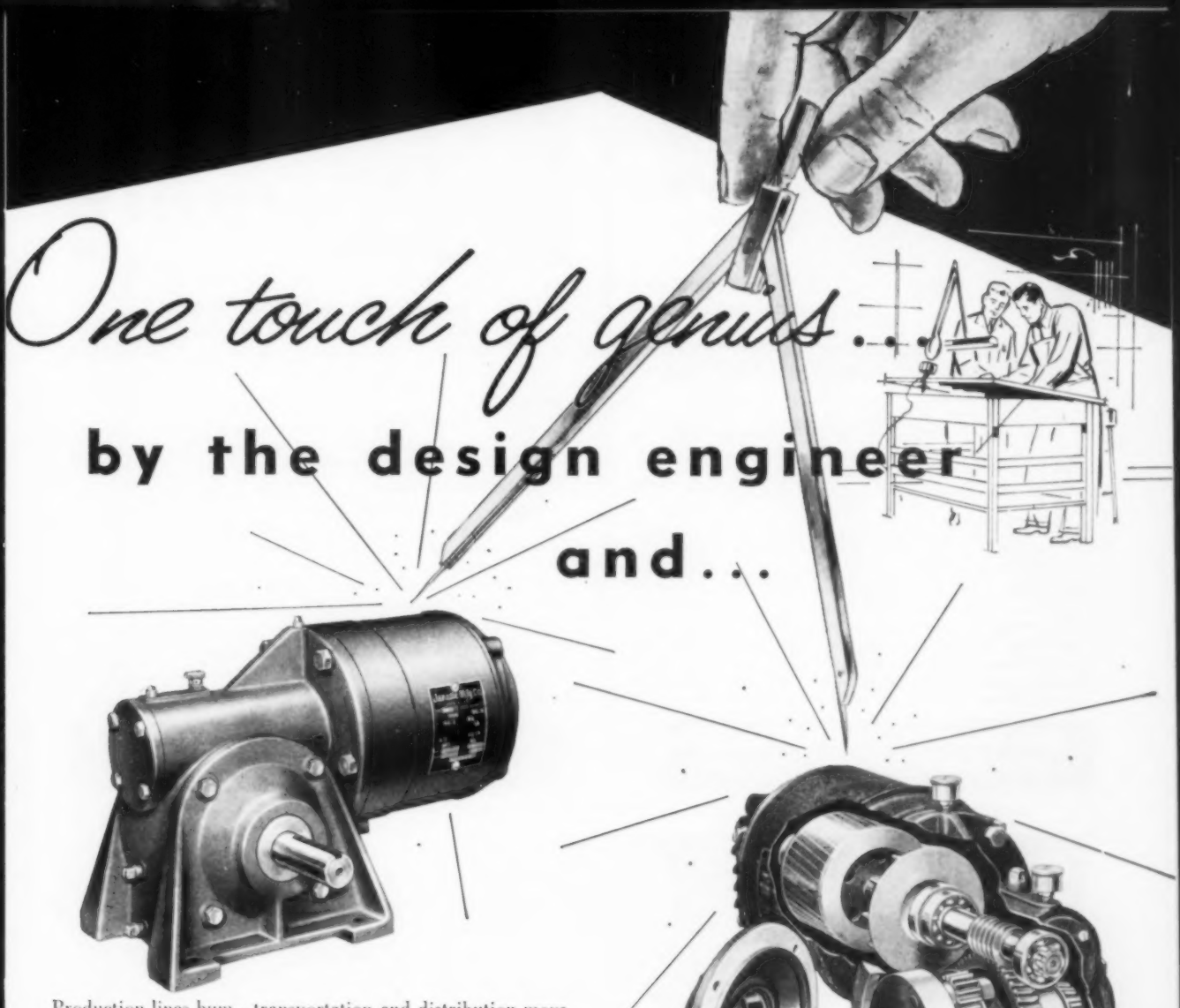
As might be expected, the volumetric efficiency of the Cessna pump is substantially better than was previously thought possible in a gear pump. The over-all efficiency and service life are similarly outstanding.

The Cessna pump has already proved itself in several of the toughest hydraulic applications, such as back hoe diggers and complex live pressure systems, as well as the more ordinary farm machinery and industrial equipment applications.

In spite of its superior qualities, the Cessna pump is economical and, because it features a versatile mounting and porting system, it is suitable for a great variety of applications. We invite your inquiries. Industrial Hydraulics Div., Cessna Aircraft Co., Hutchinson, Kansas.



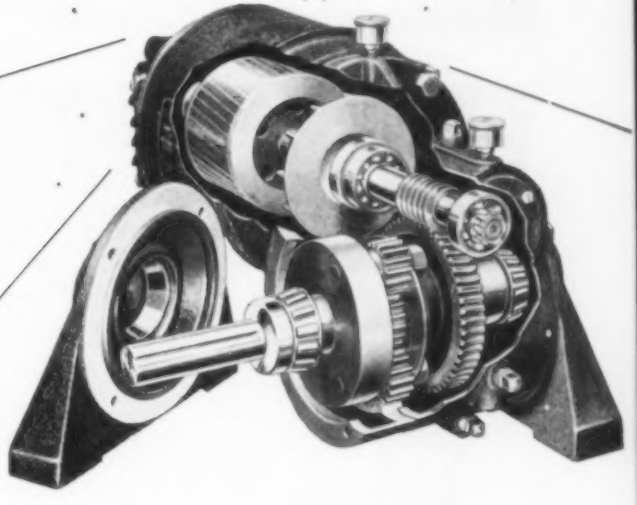
This curve was plotted from a pump with a displacement of 1.71 cubic inches per revolution. Other sizes available range from .78 to 2.04 cubic inches per revolution. Larger sizes are in the development stage.



One touch of genius...

by the design engineer

and...



Production lines hum—transportation and distribution move fast to keep up with the pace of sales.

ONE TOUCH OF GENIUS back in 1910 by a Janette engineer made it possible for all design engineers to have at all times the exact precise control of speed and power needed to give them the right speed — the right power — in one single machine — in a wide variety of models — in any horsepower from 1/150 to 7½ in any needed mounting position.

When your design includes Janette gear motors and speed reducers — the great factor of the right speed and the right power is achieved. Then you have the opportunity to design that ONE TOUCH OF GENIUS into your product which will lift that product above all competitors.

Write for Janette Bulletin 5-105-P1. Get the complete Janette story.

REPRESENTATIVES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Janette ELECTRIC MFG. CO.

MORTON GROVE, ILLINOIS

"MONOBALL"®
Self-Aligning Bearings

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Moly Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Address Dept. PE-57

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

push-pull CONTROLS

Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

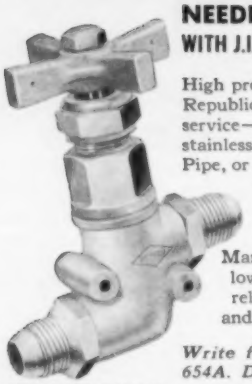
Three Types:

1. *Light Duty*—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
2. *Heavy Duty*—Compression Ult. Load 1650 lbs.; Ult. tension 960 lbs.
3. *Extra Heavy Duty*—Compression Ult. Load 3050 lbs.; Ult. tension 3900 lbs.

Positive remote controls for actuating mechanical, hydraulic or other devices. Eliminate bell cranks, pulleys and dual cables. Patented U. S. A. All world rights reserved. Send for ENGINEERING MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. PE-57

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

REPUBLIC VALVES
INDUSTRIAL • CHEMICAL • AIRCRAFT


OFFSET GLOBE VALVE

NEEDLE AND GLOBE TYPES WITH J.I.C. AND AN STANDARD TUBE ENDS

High pressure needle and globe valves by Republic have forged bodies for super duty service—brass, steel, aluminum alloy, or stainless steel. Exclusive design features. Pipe, or AN or J.I.C. tube ends, or combinations, sizes ⅛" to 2". Operating range up to 5,000 psi, −65° to 350°F.

Manufacturers also of high quality low and hy-pressure check valves, relief, 2, 3, and 4-way plug valves, and special valves to specifications.

Write for complete new catalog No. 654A. Distributors in principal cities coast to coast.

191

RM REPUBLIC MANUFACTURING CO.
15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

another first!
MOLCOTE *metallized ceramic coating*

for use with all types of hard solders!

Here's a firmly bonded metal-to-ceramic coated surface to which a metal or metallized ceramic may be hard soldered *up to 2200° F!* Its versatility permits use in a wide latitude of high temperature assembly manipulation, and its extreme refractory qualities defy the attack of solders of the copper-silver, silver, and pure copper types. No expensive preliminary processing is required. MOLCOTE'S solder bonds are exceptionally strong to the point of fracture! Like to know more? Bulletin 1155 contains all the facts. Write for a copy!

frenchtown PORCELAIN COMPANY
87 Muirhead Avenue • Trenton 9, New Jersey
CALIFORNIA REPRESENTATIVE: Edwin E. Starr, 4101 Rhodes Ave., North Hollywood, Cal. STanley 7-5879

level of men who must judge research effort from the standpoint of customer, supplier, or investor it summarizes the experience of large and small corporations in the conduct of their research establishments.

An abbreviated list of chapter headings includes: department organization, expenditures for research, budgeting, facilities, personnel, source of projects, and evaluating results.

One major conclusion has been reached. The average smaller company is neglecting profit opportunities because it is misinformed as to cost, probability of success, arduousness of research, and its own fitness to undertake it. The company which has spent and is spending more on productive research than its competitors is, or will be, the leader of its industry.

Analog Computers: Their Industrial Applications

Proceedings of a Symposium for Management, April 10-11, 1956, Kansas City, Mo. 8½ x 11 in., 210 pp. Available from Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo. $5.

This publication contains 13 technical papers and round-table discussions, covering the broad field of applying analog computers to industrial tasks. Subjects covered include use of these computers for: design and operation of engineering systems; automatic control of freight yards; operations research; flood routing and other hydraulic problems; design of aircraft-engine governors and engine-governor systems; analysis and control of chemical processes; economic programming and control; and miscellaneous applications in the petrochemical, product, and electrical-engineering fields.

Electrical Insulating Materials

Heavy paper cover, 6 x 9 in., 48 pp. Published by ASTM, 1916 Race St., Philadelphia 3, Pa. $1.75.

This symposium serves as a starting point from which further research may go forward towards solving some of the problems associated with electrical insulation. Currently it is diffi-

(Continued on page 499)

SEMS BY Everlock®

HOLD TIGHTER! COST LESS!

Ever hear someone say "they don't make 'em like they used to"? Well, it's a good thing they don't! Modern autos, for instance, last up to three times as long as the cars of twenty years ago.

Sems by Everlock are one of the reasons. Every modern auto has a thousand and one places where Sems grip tight for the lifetime of the car. The illustration shows Sems used on a station wagon tailgate. Often used for both business and pleasure, station wagons get abuse and vibration that are sure to work old-time fasteners loose. But, Sems by Everlock actually hold tighter the more you try to shake 'em loose.

Here's Why You Should Order SEMS by Everlock . . .

1. **Cut costs** by eliminating separate handling of screw and washer.
2. **Simplify ordering** by reducing the number of items carried and quantities stocked.
3. **Eliminate waste** due to lost lock washers.
4. **Eliminate rejects** due to omitted lock washers.
5. **Fast delivery** on a wide range of sizes, types and finishes.

SEMS by Everlock
Exclusive Everlock Chisel Edges firmly grip both the fastener and the product!
Everlock Sems are available in a wide range of types and sizes. Ordering "Sems" is not enough, only Everlock Sems, preassembled lock washers and screws, have the exclusive, full chisel edge locking action.

Other Everlock fasteners that feature the exclusive full chisel edge locking action include **Free Lock Washers, Locknuts and Terminals.**

THOMPSON-BREMER & CO.
516 North Dearborn Street • Chicago 10, Illinois
Subsidiary of AMERICAN MACHINE & FOUNDRY CO.

WRITE FOR FREE CATALOG . . .

Another AMF Product
Everlock
INDUSTRIAL FASTENERS

Check the Alphabetical Listing in Your Telephone Book:

EVERLOCK REPRESENTATIVES

J. J. McIntosh, Atlanta, Georgia
C. L. Martin Sales Corp., Baldwinsville, N. Y.
Richard C. Dudek, Beverly Hills, Calif.
W. L. Barth, Jr., Chicago, Illinois
Scott & Steffen, Inc., Cleveland, Ohio
Kenneth D. Delanoy, Dayton, Ohio
Sam T. Keller Co., Detroit, Michigan
C. W. McNeil, Inc., Houston, Texas
D. G. Teeling Co., Indianapolis, Ind.
James E. Cleary, Marblehead, Mass.
Thom Lundeen, Moline, Illinois
J. Ramsey Reese, Inc., New York, N. Y.
Hank Workman, Pleasure Ridge, Ky.
W. Henry Cordray Sales Co., Philadelphia, Pa.
Oregon Indust. Factors, Portland, Oregon
Howard N. Clark, Rochester, N. Y.
Forrest Moschner, St. Louis, Mo.

If you're an **engineer** whose future is being held up...

TAKE A LOOK AT THE FUTURE

YOU CAN ENJOY RIGHT NOW

AS A DOUGLAS ENGINEER!

It's important that you use your *full* talents *now*... if you are to expand in your job. This requires assignments of the scope you will find at Douglas... assignments that allow you to accomplish more and gain rich rewards. Many opportunities exist for career-minded engineers in modern Douglas plants and testing facilities across the nation. For example...

THERMODYNAMICISTS ARE NEEDED NOW!
Mechanical Engineers work on all phases of analysis, design and installation of equipment involved in heating, cooling and air distribution at high speeds.

For important career opportunities in your field, write:

C. C. LaVENE
DOUGLAS AIRCRAFT COMPANY, BOX N-620
SANTA MONICA, CALIFORNIA

Go further with DOUGLAS

FIRST IN AVIATION

TROMBETTA SOLENOID CORP.

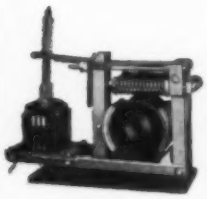
MILWAUKEE WISCONSIN

U.S.A

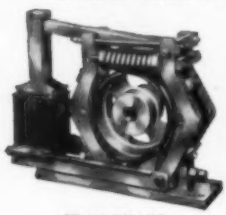
331 NORTH MILWAUKEE STREET

SOLENOID SHOE BRAKES

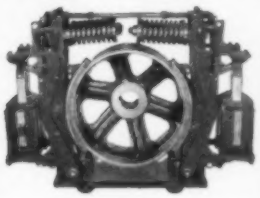
SINGLE SOLENOID OR DOUBLE SOLENOID OPERATED



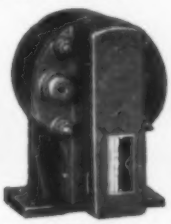
SBM-362 BRAKE
45 FT.-LBS.
MAGNETICALLY SET



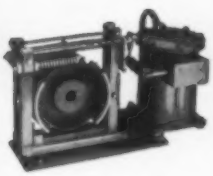
SB-373 BRAKE
450 FT.-LBS.
SINGLE SOLENOID



SB-388 BRAKE
2400 FT.-LBS.
DOUBLE SOLENOID



B-122 DISK BRAKE
85 FT.-LB. TORQUE



SB-362 BRAKE
EXPLOSION PROOF

SB-300 LINE OF SOLENOID BRAKES

SPRING SET MAGNETIC RELEASE OR MAGNETICALLY SET SPRING RELEASE.

FOR OPERATION: On alternating current at any voltage and at frequencies from 16⅔ to 67⅔ cycles per second.

On direct current shunt connections at any voltage to 750 volts. Series connections at any voltage to 750 volts and any current.

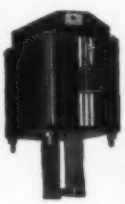
Wheel diameter ranges from 2½" to 72". Wheel face from 1½" to 14".

Torque capacity: 3 ft.-lbs. to 24,000 ft.-lbs. continuous duty; 5 to 32,500 ft.-lbs. ½ hour duty.

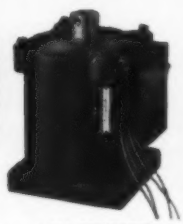
SEND FOR BULLETINS EE-180, EE-183, EE-184

STANDARD SOLENOIDS

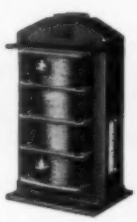
46 STANDARD LINES, 608 SIZES



F-334 SOLENOID
F-300 LINE

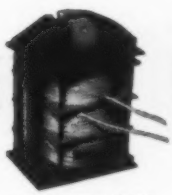


A-128 SOLENOID
A-100 LINE

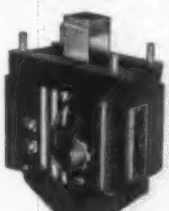


AL-828 SOLENOID
AL-800 LINE

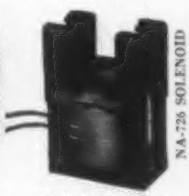
FX-324 SOLENOID
FX-300 LINE



AS-427 SOLENOID
AS-400 LINE



G-611-H SOLENOID
G-600 LINE



NA-726 SOLENOID

NATIONAL ACME
REPLACEMENT LINE

A COMPLETE LIST OF SOLENOIDS

PLAIN SOLENOIDS
F-300, 30 sizes; G-200, 14 sizes; A-200, 15 sizes; NA-700, 38 sizes; G-600, 6 sizes; A-100, 14 sizes; AL-800, 18 sizes; AS-400, 14 sizes; E-500, 30 sizes; FW-300, 30 sizes; EW-500, 30 sizes.

DOUBLE PLUNGER SOLENOIDS
AD-300, 15 sizes; AD-400, 7 sizes; AD-800, 9 sizes.

EXPLOSION PROOF SOLENOIDS
FX-300, 15 sizes; FX-800, 9 sizes; FX-400, 7 sizes.

OIL IMMERSED SOLENOIDS
FZ-300, 15 sizes; FZ-800, 9 sizes; FZ-400, 7 sizes.

PURE DIRECT CURRENT SOLENOIDS
A-100, 14 sizes from 2 lbs. to 100 lbs. at 85% voltage.

SOLENOID OPERATORS
RD2-300, 15 sizes; RD2-800, 9 sizes; RD2-400, 7 sizes; RD3-300, 15 sizes; RD3-800, 9 sizes; RD3-400, 7 sizes.

DIRECT CURRENT OPERATORS
RD2-100, 7 sizes; RD3-100, 7 sizes.

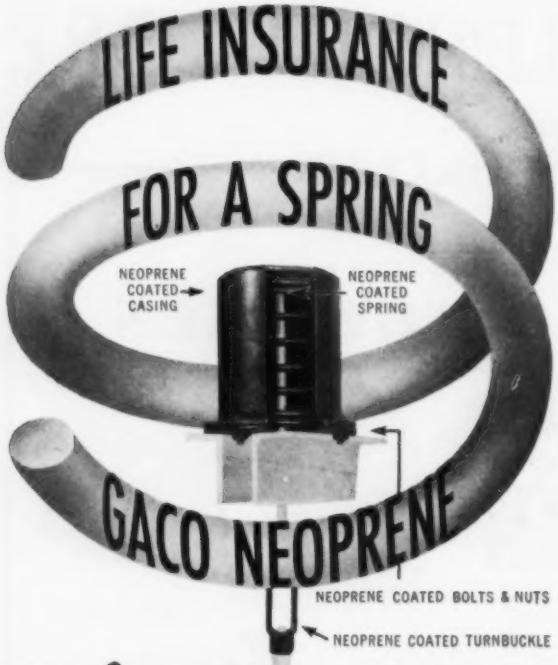
EXPLOSION PROOF OPERATORS
RD2X-300, 15 sizes; RD2X-800, 9 sizes; RD2X-400, 7 sizes; RD3X-300, 15 sizes; RD3X-800, 9 sizes; and RD3X-400, 7 sizes.

OIL IMMERSED OPERATORS
RD2Z-300, 15 sizes; RD3Z-800, 9 sizes; RD2Z-400, 7 sizes; RD3Z-300, 15 sizes; RD3Z-800, 9 sizes; and RD3Z-400, 7 sizes.

EXPLOSION PROOF DOUBLE PLUNGER SOLENOIDS
ADX-300, 15 sizes; ADX-800, 9 sizes; ADX-400, 7 sizes.

OIL IMMERSED DOUBLE PLUNGER SOLENOIDS
ADZ-300, 15 sizes; ADZ-800, 9 sizes; ADZ-400, 7 sizes.

IN 1924 MR. TROMBETTA GAVE THE WORLD THE COMMERCIAL SOLENOID



Flexible
GACO NEOPRENE

Protects Grinnel Spring Hangers from

CORROSION AND EXPOSURE

Grinnel Company engineers had a tough design problem: to protect spring hangers against highly corrosive industrial fumes and severe weather exposure *without* affecting the flex life of the spring.

Tough, flexible, GACO neoprene provided the solution. All parts of the hanger are neoprene coated to protect the base metal from a wide range of corrosives found in chemical plants and refineries. Flex life of the spring is unaffected by GACO neoprene . . . the flexible adhesive coating envelops metal parts . . . will not crack or flake over a wide temperature range. For outdoor installation, GACO neoprene was specified for the spring coating to avoid alteration of temper, hydrogen embrittlement and decreased flex life.

New design problems call for new materials. Investigate GACO neoprene coatings where severe operating conditions demand a tough, flexible, corrosion-resistant coating. A wise policy—insure the life of *your* product with GACO neoprene protective coatings.

WRITE: We'll forward literature of interest.

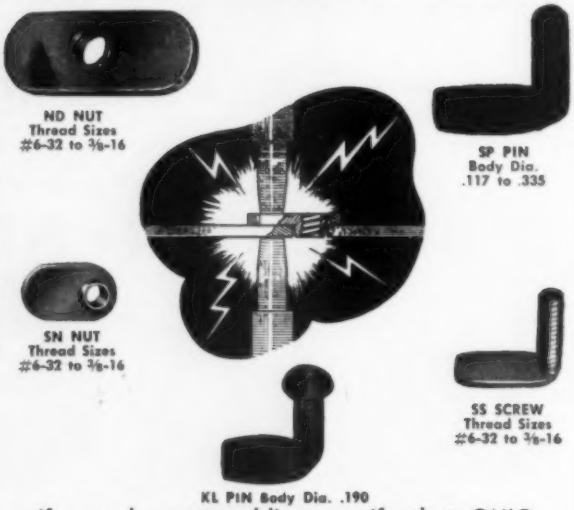
THE MARK OF CORROSION PROTECTION

GATES ENGINEERING COMPANY
Wilmington 99, Delaware

PIONEER LEADER IN PROTECTIVE COATINGS

Authorized Distributors in principal cities U.S.A. • Australia • Belgium • England • Finland • France • Israel • Japan • Norway • Okinawa • Philippine Islands • Puerto Rico • Sweden. In Canada: Gaco Products Ltd., Brantford, Ontario.

OHIO SPOT WELD FASTENERS

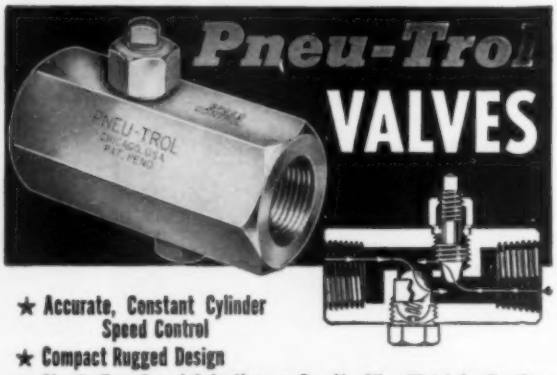


If you do spot welding specify that OHIO stock spotweld parts be attached at the same time for faster, trouble-free assembly.

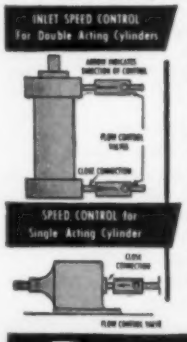
Samples and information available upon request.

Specialists in the Manufacture of Weld Fasteners and Adjusting Screws

THE OHIO NUT AND BOLT COMPANY
14 First Avenue BEREA, OHIO



★ Accurate, Constant Cylinder Speed Control
★ Compact Rugged Design
★ Simple, Easy Speed Selection ★ For Air, Oil or Water Applications

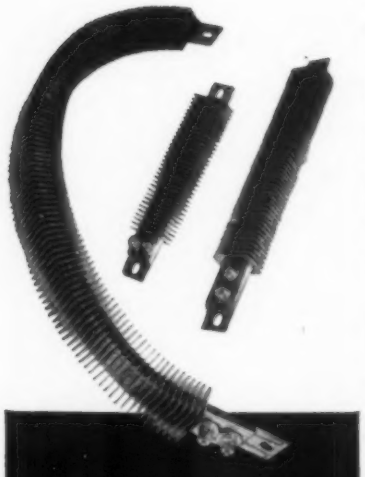


Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes—⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

Write for illustrated circular and prices.

Pneu-Trol DEVICES, INC.
1440 N. KEATING AVENUE • CHICAGO 51, ILL.



Air temperatures to 950° F accurately controlled in heaters, dryers, ducts, ovens with CHROMALOX® Electric Finstrip Heaters

For drying, baking, curing, space heating . . . anywhere you need uniform heat under forced circulation, here is the clean, fast, economical answer. Chromalox Electric Finstrip Heaters install quickly and easily as individual units, or as factory assembled banks. Low original cost. Maintenance-free. Parallel fin design permits maximum heat with minimum turbulence of air stream. Choice of steel or chrome sheaths. Moisture proof types available.

FREE—Send today for these 2 BIG HEATING HELPS

Catalog 50—Describes complete Chromalox Electric Heating line.

Booklet F1550—"101 Ways to Apply Electric Heat."

Edwin L. Wiegand Company
7535 Thomas Boulevard • Pittsburgh 8, Pa.
C-2116

cult in many instances to secure enough information covering electrical, physical and chemical properties to predict accurately the insulating properties of these materials.

The symposium includes several papers which answer some of the requirements for determining insulating properties. Among these are: "Significance of Minimum Property Values of Electrical Insulating Materials"; "Extreme Nature of Dielectric Breakdown-Effect of Sample Size"; "Establishment of Minimum Quality Levels of Sheet Insulation"; "Variability of Dielectric Breakdown in Sheet Insulation"; "Low-Temperature Resistance Test Methods for Non-Rigid Insulation"; "Statistical Treatment of Heat-Aging Studies on Varnished Glass Cloth"; "Quality Level Cannot Be Determined by Go-No-Go Gage."

Mechanisms and Dynamics Of Machinery

HAMILTON H. MABIE and FRED W. OCVIRK, *Cornell University*. 6 x 9¼ *in.*, 442 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York 16, N. Y.* $8.50.

This college text on mechanisms and dynamics of machinery has been streamlined to include space for the discussion of such topics as analytical cam design, non-standard gearing, computing mechanisms, synthesis, and dynamic analysis of rotating and reciprocating machinery. Many examples are included. It is assumed that the reader has completed courses in physics, calculus, statics and dynamics.

Human Engineering Guide For Equipment Designers

WESLEY E. WOODSON, *U. S. Navy Electronics Laboratory, San Diego*. 8 x 10½ *in.*, 227 *pp. Published by University of California Press, Berkeley 4, Calif.* $3.50.

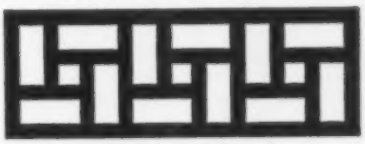
Probably the best single-volume reference on human engineering for designers has been reprinted. The data was originally compiled for the Bureau of Ships in order to bring together, in easily usable form, informa-

(Continued on page 501)

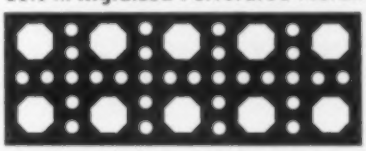
DIAMOND PERFORATED METALS

FOLLOW THE TREND

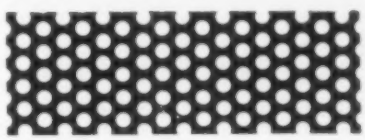
toward development of more attractive products through the greater use of DIAMOND ORNAMENTAL PERFORATED METALS.



Perforated-Metal Sections supplied by Diamond to other manufacturers include **Grilles** and **Louvers**, for air conditioners, radios, juke boxes, television sets, automobile instruments, etc. Furnished also, for many modern products in **Rigidized Perforated Metal.**



Screens, for industrial processing, sterilizers, etc.; **Panels**, for space heaters, etc.; **Oil-Burner Chimneys**; **Perforated Cylinders**, for washing-machine and other centrifugal dryers; **Accoustical Sheet**; **Sound Baffles**; **Welded and Fabricated Assemblies** of all kinds.



Tooled for a great variety of perforations in any commercial metal, of any suitable thickness. **Geared** to meet the production schedules of America's leading industrial concerns—that's Diamond.

Want to know more about us and what we might do for you? Write for Catalogue No. 39.

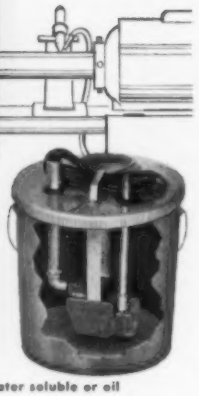
DIAMOND MANUFACTURING CO.
Box 40 WYOMING (Wilkes-Barre Area) PENNA.

West Coast Plant, Diamond Perforated Metals Co.
17915 So. Figueroa St., Gardena, California
Los Angeles Area

LITTLE GIANT PORTABLE

COOLANT UNIT

WITH SUBMERSIBLE RECIRCULATING PUMP FOR MACHINE TOOLS!



This Portable Coolant Unit is bringing new efficiency and trouble-free economy to machine shops all over the country. The only Coolant Unit on the market with a recirculating pump that can be submerged inside the coolant tank, free from damage.

- Operates efficiently with either water soluble or oil base coolants.
- Heavy duty motor, hermetically sealed in oil.
- High grade aluminum die-cast case.
- Sturdy Metal Coolant tank.
- Screened trap to catch cuttings and chips
- U/L approved glass insulated terminals and many other outstanding features.

Write for free catalog and price list of all Little Giant Liquid Handling Products today.

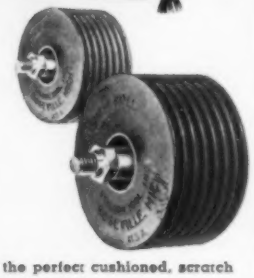
Little Giant PUMP COMPANY

Division of Little Giant Vaporizer Company, Inc.

5101 Classen Blvd., P.O. Box 9545, Oklahoma City 18, Okla.

AUTOMATION!

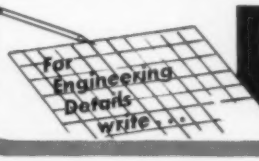
DESIGN YOUR CONVEYORS TO *Cushion* PARTS ON STILSON *Rubber Rollers*



Stilson Rubber Rollers provide the perfect cushioned, scratch free ride for all types of production parts.

Used on gravity conveyors, die lifters, or idler rolls under conveyor belts, Stilson Rollers assure positive surface protection during transportation and safety for glass or other fragile products.

Stilson Rollers are available in 2½ and 4 inch diameters and in a variety of models. They operate on a dual ball bearing axle and all parts are interchangeable.

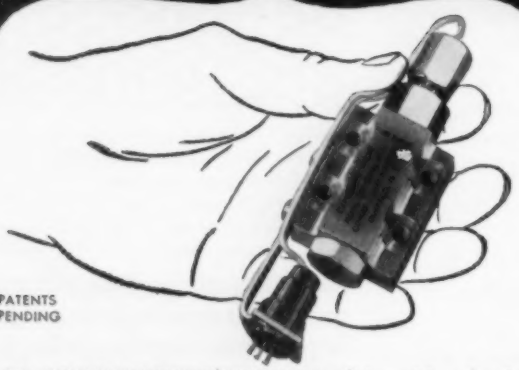


STILSON TOOL INC.

30229 Groesbeck Hwy. Roseville, Mich.

CONAX®

EXPLOSIVE VALVES



PATENTS PENDING

The CONAX EXPLOSIVE VALVE is a light-weight valve that operates instantaneously upon the firing of a small, completely contained explosive squib. The "Normally Closed" model provides dead-tight shut-off before firing and may be used for long term storage of gas or liquid under high pressure. Weighs only 5 ounces... releases in .002 seconds... operating pressures to 6000 psi... proof pressure to 10,000 psi... ZERO LEAKAGE at 10,000 psi... smallest possible envelope size.

Write for Catalog 5501-XV

EXPLOSIVE PRODUCTS DIVISION

CONAX CORPORATION

2300P WALDEN AVE., BUFFALO 25, N. Y.

OHIO'S "D SERIES"

DESPITE HEAT, COLD, FUMES AND SHEER PHYSICAL STRAIN, Ohio Carbon's "D Series" have provided long life and improved commutation on rotating electrical equipment operating in adversity.

Their toughness—distilled through 40 years of engineering and testing, has proved equal to any task. Recommended as well, for general service on DC Generators and Synchronous Converters.

Write factory today, for free catalog 18-A, which describes entire brush line.

The OHIO CARBON COMPANY

12508 Berea Road, Dept. 285, Cleveland 11, Ohio

tion scattered throughout the literature.

Individual chapters cover the design of equipment and work space, vision, audition, body measurement and other factors including body sensitivity, movement and control and orientation. Individual reference lists are included at the end of each chapter and a bibliography and suggested reference library are appended.

Bibliography of Electronic Research Reports

PB 121779, U. S. Dept. of Commerce, Office of Technical Services, 8½ x 11 in., 50 pp, paper-bound. Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. $1.50.

Reports listed in this publication were released in the interest of industry between Jan. and Dec. 1956 through the Office of Technical Services by the Army, Navy, Air Force, and other agencies of the Government. Some of the reports are available from OTS in printed form; others are deposited at the Library of Congress and are available from the Library in microfilm or photocopy only. Source is given with each report. This list of reports is a reprint of the electronics sections from the Jan.-Dec. 1956 issues of the monthly OTS publication. These research reports release 300 to 600 reports of Government-sponsored-technical research in all fields.

Chemical Analysis of Metals

Cloth cover, 6 x 9 in., 640 pp. Published by ASTM, 1916 Race St., Philadelphia 3, Pa. $8.

The 1956 edition is the first complete revision of this volume since 1950. It contains all ASTM methods for chemical analysis of ferrous and non-ferrous metals and alloys, including spectrochemical procedures.

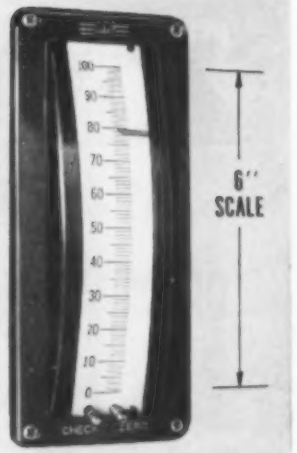
There are ten completely new methods and recommended procedures in the book. These include chemical analyses for electronic nickel and titanium and two important recommended practices in the field of spectrochemical analysis. In addi-

(Continued on page 503)

NEW, MINIATURE ATCOTRAN INDICATOR SYSTEM

ACCURATE, DEPENDABLE, LOW-COST INDICATION OF MECHANICAL DISPLACEMENT

If your variable can be detected in terms of linear change in position, this system will provide a low-cost indication of that variable. OEM's please note!



TEMPERATURE • PRESSURE • LEVEL • WEIGHT • DISPLACEMENT DIMENSION • POSITION • ETC.

COMPLETE SYSTEM

Atcotran Indicator System consists of a differential transformer (± 0.15" motion) transmitter which sends an a-c signal proportional to change in the measured media and a "linear motor" which drives the pointer. The null-balance circuit is not critically affected by normal line voltage fluctuations.

ACCURATE

Atcotran vertical scale indicators are readable to ½ per cent. Linearity is ±½ per cent and repeatability is better than ±¼ per cent.

DEPENDABLE

This instrument utilizes the ATC performance proven amplifier circuit. Its electronic components are very conservatively rated and will provide long trouble-free operation without servicing.

VERSATILE

The wide variety of quantities measured by Atcotran Indicator Systems permits a high degree of standardization. 0-100 scale is standard, special scales are supplied on order. Unit plugs into 115 volt, 60 cycle outlet. ILLUMINATED SCALE. Designed especially for panel board mounting. An excellent tool for "Graphic Panel" applications, Test Cells, Process Control Systems, etc.

LOW COST

First unit is well under $200. Quantity orders permit substantial reductions.

atc®
AUTOMATIC CONTROL SYSTEMS & COMPONENTS

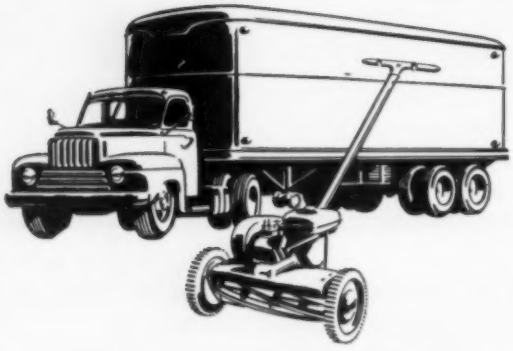
AUTOMATIC TEMPERATURE CONTROL CO., INC.
Subsidiary of Safety Industries, Inc.
5244 Pulaski Avenue, Phila. 44, Pa.
Please send me complete data on Atcotran Miniature Indicator Systems.

NAME_____
COMPANY_____
STREET_____
CITY_____ ZONE____ STATE_____

FOREIGN SALES: ATC EXPORT DEPARTMENT, 1505 RACE ST., PHILA 2, PA.

Zenith

HAS A WIDE RANGE OF CARBURETOR TYPES



TO FIT A WIDE RANGE OF APPLICATIONS!

Are you looking for an unusual size or type of carburetor? Perhaps Zenith* has the answer to your problem. For more than 35 years Zenith has been designing and building carburetors for every type of engine—ranging from single cylinder lightweights to the most rugged and powerful of gasoline engines. The chances are you can use a unit Zenith is now making and avoid the cost of a specially designed carburetor.

On the other hand, if your carburetor requirements are highly specialized, Zenith's engineering experience will prove invaluable in solving questions of placement, efficiency and economy of operation. Just remember, whatever your carburetor problem, it will pay you to look to Zenith for the answer.

*REG. U. S. PAT. OFF.

ZENITH CARBURETOR

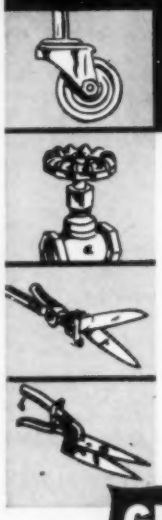
DIVISION OF Bendix
AVIATION CORPORATION

696 Hart Avenue, Detroit 14, Michigan

MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

Use this THIN
GRIPCO JAM NUT
FOR
- Valve Handles
- Casters
- Shears
- Clippers
- Sickle Bars



or wherever you need a positive lock on short bolts where the strength of a full nut is not needed.

GRIPCO JAM NUTS come in the New Unified Finished and Heavy Series (Hexagon), in standard full and jam dimensions, in steel, brass and aluminum.

Gripco Products Include:

Gripco Lock Nuts • New Gripco "Clinch Nuts" Gripco Hi-Nuts • Gripco Pilot-Projection and Countersunk Weld Nuts
all with or without the famous Gripco positive locking feature. Also Standard Semi-Finish Nuts.

Write for samples and full particulars.

117

GRIP NUT COMPANY
102 Maple Ave. • South Whitley, Ind.

Grayhill INC.

Series 24
Multi-Deck

- Miniature
- Positive Detent Action
- Commercial or Military use
- Available from 1 to 6 decks (10 positions per deck) from stock

Write for Bulletin M-200

Grayhill INC.

Telephone FLeetwood 4-1040

557 Hillgrove Avenue, La Grange, Illinois

Midget Tap Switches

Just Out

ELECTRONIC COMPONENTS HANDBOOK

For the designer of military and commercial electronic equipment. Furnishes data on resistors, capacitors, relays and switches as an aid in selecting the best unit for a particular job so that maximum reliability of the end product results. Gives good and bad points; includes effects of heat, humidity, high altitude, low pressure, shock, and other environmental factors. **Edited by Keith Henney and Craig Walsh. 224 pp., illus., $9.00**

MECHANICAL DESIGN FOR ELECTRONICS PRODUCTION

Gives engineers an understanding of the special problems of manufacturing devices using electron tubes and transistors, to aid in designing equipment that will combine best qualities of durability and economy. Gives information on a wide variety of processes and materials, including mechanical layout, sheet metal work, sealing compounds, etc., etc. **By J. M. Carroll, Managing Editor, Electronics. 452 pp., illus., $6.50**

BUILDING AN ENGINEERING CAREER

***JUST OUT* Brings you helpful guidance in choosing the kind of engineering career in which you will be successful.** Plainly and thoroughly explains the scope of each engineering branch, the kind of work involved, the chief accomplishments of each, income and job possibilities, and gives pointers on preparing for such a career. **By C. C. Williams. 3rd Ed. rev. by E. A. Farber, U. of Fla. 297 pp., 60 illus., $4.75.**

PROFESSIONAL ENGINEER'S EXAMINATION QUESTIONS AND ANSWERS

Over 500 questions and complete answers to help engineers pass state license examinations. Covers mechanical, electrical, civil, and chemical engineering, and includes engineering economics and land surveying. Latest questions—suitable for all states. Author has worked on New Jersey examination preparation for 19 years. By William S. LaLonde, Jr., 462 pp., 234 illus., $6.50.

10 DAYS' FREE TRIAL

McGraw-Hill Book Co., Inc., Dept. PE-5
327 W. 41st St., New York 36, N. Y.

Send me the book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs, if you remit with this coupon — same return privilege.)

- ☐ Henney & Walsh—Elect. Comp. Hdbk., $9.00
- ☐ Carroll—Mech. Design for Elect. Prod., $6.50
- ☐ Williams—Building Eng. Career, $4.75
- ☐ Lalonde—Prof. Engrs. Exam. Q. & A., $6.50

(PRINT)
Name .....
Address .....
City ..... Zone.... State.....
Company .....
Position .....

For price and terms outside U.S. write McGraw-Hill Int'l, N.Y.C. PE-5

tion, ten standards have been substantially revised since 1950. The book contains 42 methods of analysis including four spectrochemical procedures. There are five recommended practices and one specification. Some of the standards contain comprehensive diagrams of apparatus and pertinent charts.

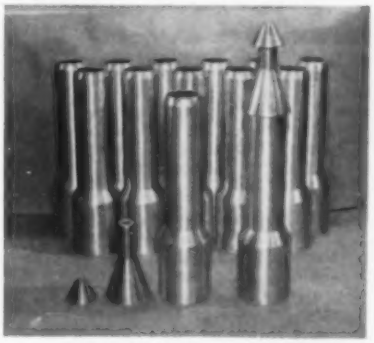
Petroleum Products and Lubricants

6 x 9 *in.*, 1096 *pp. Published by ASTM, 1916 Race St., Philadelphia 3, Pa. Cloth cover,* $7.50; *paper cover* $6.75.

This compilation prepared by ASTM committee D-2 includes tentative and standard methods of test, specifications, definitions of terms and classifications of petroleum products and lubricants with related information. This book has been published annually since 1927; the present edition includes 180 standards, 48 of which are new or revised since the previous edition.

Some of the new standards are methods of test for: tetraethyl lead in gasoline, D 526; evaporation loss of lubricating greases and oils, D 972; mercaptan sulfur in jet fuels (color-indicator method, D 1219) (amperometric method, D 1323); and analysis of calcium and barium petroleum sulfonates, D 1216.

DESIGN your products for SPINNING



Parts spun to tolerances of ± .003"

. . . by the exclusive

Mecatorn PROCESS

It's fast and it's economical

Metal spinning, by the MECATORN Process can cut your costs and simplify your designs. Torngren has all facilities for taking over both spinning and whatever welding may be involved in assembling. Ask one of our qualified staff to assist you in adapting your designs to production by spinning and save time, money and worry.

Capacities of the MECATORN Process

Metal	Gauge	Diameter
Aluminum	Up to 3/16"	Up to 16"
Aluminum, copper, bronze	Up to 1/8"	Up to 4"
Low alloy steels	Up to 3/16"	Up to 4"
Low alloy steels	Up to 1/8"	Up to 6"
Stainless Steels	Up to 1/16"	Up to 6"

Spinnability of Metals

Ease of spinnability varies with the metal . . . some are easy, others average, some difficult while others are very difficult. Some metals require annealing, some are spun hot and some require little annealing. Our engineers will give you exact and definite information on this subject so that it may be of assistance in determining the metal best suited for your product in the event you make spinning your method of production. Incidentally, in many spinning operations tolerances can be held to a few thousandths of an inch.

Engineering Service

Our engineering staff will be glad to assist in adapting your designs to the spinning process. Literature available on request.

C. W. TORNGREN CO.

SOMERVILLE 45, MASS.

NOISELESS
CASTERS
WITH JARVITE

the long wearing, hard rubber compound that's kind to your floors.

"Jarvite" high-strength, hard rubber compound performs capably in humid temperatures ranging from 32° to 100° F . . . will not develop soft spots or damage wood floors, unaffected by fats such as shortening, fruit acids, milk acids, flour, etc.

Protective stud cap shields vital grease-packed raceways from steam and hot water . . . ball bearings are packed with high quality, high-low temperature water resistant grease.

Dust and moisture shield protects cup-and-cone wheel bearing assembly from hot water, steam, lint dust, sawdust, threads, etc.

Intermediate raceway is also designed to provide a combination dust guard and moisture shield to protect the lubrication.

Model 5"-48-116

TESTED IN BAKERIES AND DAIRIES AND PROVED RESISTANT TO:

Steam and Hot Water Cleaning
Food Freezing Operations
Sanitation Treatment Fats Fruit Acids
Milk Acids High Humidity
Wide temperature extremes 32° to 100° F
Chipping Impact Frozen Dough

ARE YOUR CASTERS SUBJECTED TO CONDITIONS LIKE THESE?

If so, you can reduce maintenance costs with the J & J Model 5"-48-116 Caster with Jarvite tire. Jarvite withstands heavy loads (up to 1800 lbs.) without flattening, yet permits smooth movement over fine wood floors without gouging, marking or rutting the surface.

Model 48-116 casters are designed throughout for rugged resistance to adverse conditions, particularly those involving moisture and extremes of temperature. Note the features illustrated at left: your assurance of top performance and long life service.

*(Set of four 5" casters)

Jarvis AND Jarvis, Inc.
PALMER, MASSACHUSETTS

Sold Through Quality Dealers

In Canada: Jarvis & Jarvis of Canada, 1744 William St., Montreal, Que.

Ambruger
Quick Prices... Quality Production
Prompt Delivery for Every Need!
Complete facilities, including a fully-equipped shop to make necessary tools and dies, are at your service to produce the finest plates of every type:
Name Plates
Signs
Dials
Gauges
Data Plates
Instruction Plates
Panels
Components
Any Process . . . Any Metal . . . Any Colors
Decorative Bezels, Escutcheons, Intricate Formings
You are invited to take advantage of the skill of our designers without obligation. Send for free booklet showing Mayer's unsurpassed facilities for serving you!
GEORGE J. MAYER CO., "Since 1884"
544 East Market Street • Indianapolis, Ind.
Sales Offices in Leading Industrial Centers
NAME PLATES BY
MAYER
Add Fame to Your Name
LINK-BELT
ROLLER CHAIN DRIVE
White

LIFE OF RECIPROCATING ROLLER BEARINGS EXTENDED 6.75 TIMES

WITH
MOLYKOTE®
LUBRICANTS...

This is but one example of MOLYKOTE's effectiveness in industry. Here are others:

- . . . reduced starting friction by factor of 5 in miniature precision ball bearings. (Field Report 32)
- . . . reduced to ½ the torque required to give 4000 lbs. tension in threaded connections. (Field Report 24-46)
- . . . allowed load increase from 3 H.P. to 5 H.P. on worm gears of single reduction speed reducers. (Field Report 24-41)
- . . . increased cycles from 28,000 to 700,000 in tests on brass taper air valves. (Field Report 4)
- . . . raised Oilite bearing life from 6 to 46 hours. (Field Report 24-47)
- . . . raised life to failure time from 120 to 400 hours on sintered bronze bearings; reduced wear in 12 hour test from .002 to .001. (Field Report 43)

MOLYKOTE Field Reports are filled with thousands of these case histories. Write for your copies . . . but be sure to mention your application.

THE ALPHA MOLYKOTE CORP.

Main Factories: 65 Harvard Avenue, Stamford, Conn.
71 Arnulfstrasse, Munich 19, Germany

782

PRESS PREVIEWS

New Company to Provide Computer Service

A new firm, The DATICS Corp., in Fort Worth, Texas, offers services in electronic computing and data processing (datics) on a contract basis to solve scientific and industrial problems. Facilities include an electronic digital computer, data reduction equipment, and various data processing machines. The computing facility is comprised of three units: The "stored" program computer console, the power unit, and the read-punch unit. Data is recorded in punched cards from original documents. The read-punch unit interprets these cards and feeds the information into the computer at a maximum rate of 200 cards, or 16,000 characters per minute. This unit also prepares the output of the computer in punched card form. The power unit contains the power supply and translating circuits for input and output.

All calculating is done in the console unit, which contains a magnetic drum "memory" of 20,000-digit capacity. This drum stores both the data to be processed and the instructions necessary for calculation. The operator maintains, through the console, communications with the computer at all times. He can take a reading of the contents of the drum, inspect the progress of the problem, or enter or modify instructions or data at any time. The computer is equipped with checking circuits at all critical points. When an error is detected, it will stop; or it can be programmed to repeat that portion of the computation which is in error.

Lithium Institute to Sponsor Research on Alloys and Glass

The American Lithium Institute has initiated a program of sponsored research on lithium alloys at MIT and on lithium-containing glass at Pennsylvania State University. The

(Continued on page 507)

AQ* ------CUTS SHORT RUN STAMPING COSTS--------

PROBLEM:
Relay Support Bracket with
9 holes—two different sizes
Tolerance—hole dia. + .002/— .001; location ± .003
Blank size (developed)—1¼" x 3"
Material—.062 C. R. Strip Steel

RELAY BRACKET HOLE PUNCHING ANALYSIS

CONVENTIONAL	Single Hole "Short Run" jig punching Tools and first 1,000 pieces Subsequent re-runs 1,000 pieces	$125.00 $102.00
CONVENTIONAL	"Permanent Gang Die" Punching Tools and first 1,000 pieces Subsequent re-runs 1,000 pieces	$266.00 $11.00
FEDERAL	"Multiple Hole Process" Punching Tools and first 1,000 pieces Subsequent re-runs 1,000 pieces	$70.00 $41.00

In analyzing the problem it was found that only through Federal's multiple hole-punching process could stamping costs be cut and still hold to rigid tolerances. Let Federal quote on your next *problem piece* and save!

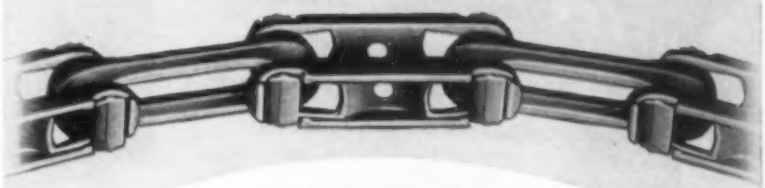
Send your print, sketch or piece for our . . .

*Analyzed Quotation

Federal TOOL & MFG. CO.
Quality Stampings in Small Quantities
3620 Alabama Ave., Minneapolis 16, Minn.

SEE . . . Our NEW COLOR FILM • BOOTH 1523 DURING THE DESIGN ENGINEERING SHOW • MAY 20-23

WILMOT
The Original Rivetless Chain for Trolley Conveyors



IMPROVED X-458 DESIGN
Has Greater Strength — Same Weight

For years a standard for continuous overhead conveyors, the improved X-458 rivetless chain provides even greater flexibility for vertical bends, and greater strength without increase in weight. This was effected by adding a web at center of side link and revising the radii of certain bearing surfaces. X-458 chain is drop-forged, heat-treated, with ave. ult. strength of 50,000 lbs., and weight of 3.125 lbs. per ft. Wilmot lists the largest choice of rivetless chain sizes. Any one will interchange with the same number of any other chain.

Send for 248-pg. Wilmot Chain Cat.

WILMOT ENGINEERING CO • Hazleton, Pa.

"ADJUSTABLE STROKE" MIDGET Air-Clamp® CYLINDER

®TRADEMARK

Now—put pressure where it's wanted instantly and cheaply, with Mead's powerful new midget air cylinders (1" bore, single-acting, spring return—horizontal and vertical). Stroke is adjustable. Cut costs—use 'em singly or in groups to move, hold, press or eject small work pieces; to close and open large jigs, forms, fixtures. They'll replace human fingers and mechanical clamps in countless routine jobs.

Catalog Free!

Write for new fact-and-picture-packed Air Power Catalog—or ask your nearest Mead Man!

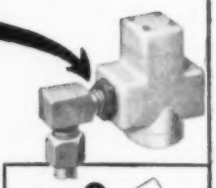
MEAD SPECIALTIES COMPANY
4114 N. Knox Ave., DEPT. PE-57
CHICAGO 41, ILLINOIS

PATHFINDER IN AIR POWER AUTOMATION

TRU-O-SEAL TEFLON SEAL

PAT. PENDING

STOPS PIPE THREAD LEAKS



Satisfaction Guaranteed Or Money Back TRIAL OFFER

TRU-O-SEAL Fittings are guaranteed to seal pipe thread connections permanently against all oils, practically all known chemicals and gases; to seal under high pressures or vacuum; to withstand —280° to plus 500° F.; to eliminate "overtightening" damage and pipe dope. Available in ⅛" to 2½" pipe thread sizes.

$10.00 Trial Offer No. 1: eight ⅛", ten ¼", eight ⅜", ten ½" pipe thread TRU-O-SEAL Fittings.

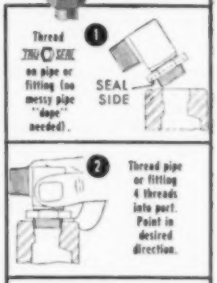
$10.00 Trial Offer No. 2: eight ½", ten ¾", four 1" pipe thread TRU-O-SEAL Fittings.

Send order to

TRU-O-SEAL DIVISION
Flick Reedy Corporation

2002-04 N. Hawthorne, Melrose Park, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

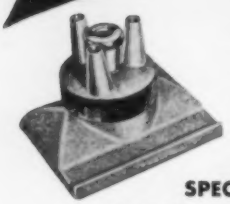

1
Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2
Thread pipe or fitting 4 threads into port. Point in desired direction.
3
Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

SPECIAL... GET ACQUAINTED OFFER SAVES $2.00!

Apsco®

TRI-POINTER

Ideal for mechanical draftsman clutch-type pencils!



A standard drawing board necessity!! Coded nozzles for instant selection of 3 points: needle, medium and blunt. No graphite "sprinkles." Special cleaning pot keeps drawing board, hands and work clean.

SPECIAL LIMITED OFFER!

Apsco Tri-Pointer ..... reg. price $6.95
Replacement Kit ..... reg. price $1.00

Yours for ONLY $5.95 ~~$7.95~~

THIS IS A LIMITED OFFER — ACT NOW!

Built and guaranteed by APSCO, world's largest manufacturers of pencil sharpeners and stapling machines — America's Choice!

Apsco products inc. Apsco

P. O. Box 840 — Dept. 1 Beverly Hills, California.

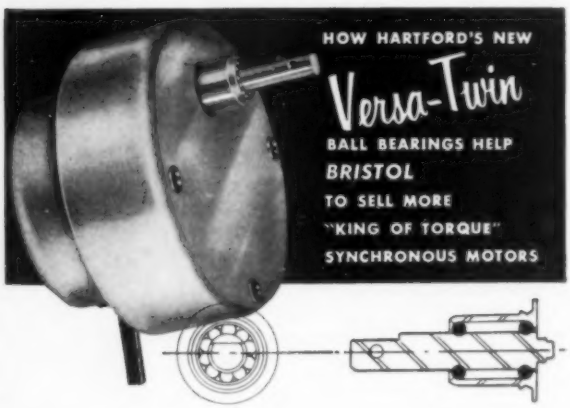
Please rush to me One (1) Tri-Pointer @ $5.95 special, plus One (1) Free Replacement Kit. Check or money order — no C.O.D.'s or cash, please. We will prepay.

Name_____

Company affiliation_____

Address_____

City_____ Zone____ State_____



HOW HARTFORD'S NEW **Versa-Twin** BALL BEARINGS HELP *BRISTOL* TO SELL MORE "KING OF TORQUE" SYNCHRONOUS MOTORS

VERSA-TWIN is a double-row unground ball bearing with high performance and controlled tolerances in which parts of the end product form the inner and outer races. The advantages of VERSA-TWIN are many. For example, here is what VERSA-TWIN does for the Bristol Model 444BB Synchronous Motor . . . (1) permits motor to be mounted in any position because VERSA-TWIN carries both radial and thrust loads in both directions. (2) Has made many new motor applications possible, resulting in (3) increased sales. (4) Lengthens motor life. If you are designing a new product or redesigning an old one, VERSA-TWIN may offer you many desirable features. Write for descriptive literature and data sheets on versatile VERSA-TWIN..

Hartford
PRECISION BALLS • BEARINGS

The Hartford Steel Ball Co., Inc., 3 Jefferson Ave., W. Hartford 6, Conn.

Institute will also establish fellowships at the two institutions. The purpose of this work is to broaden basic information on known lithium alloys and to develop data on unknown lithium alloy systems to; aid in evaluating their potentialities as new materials of construction. It is also hoped that this research will shed light on one or more of the beneficial effects lithium has on glass: increase in strength, improvement in electrical properties, and improvement in optical properties.

Member companies of the American Lithium Institute, Inc., are the three major U. S. lithium producers—American Potash and Chemical Corp., Foote Mineral Co., and Lithium Corp. of America.

New Bearing Plant

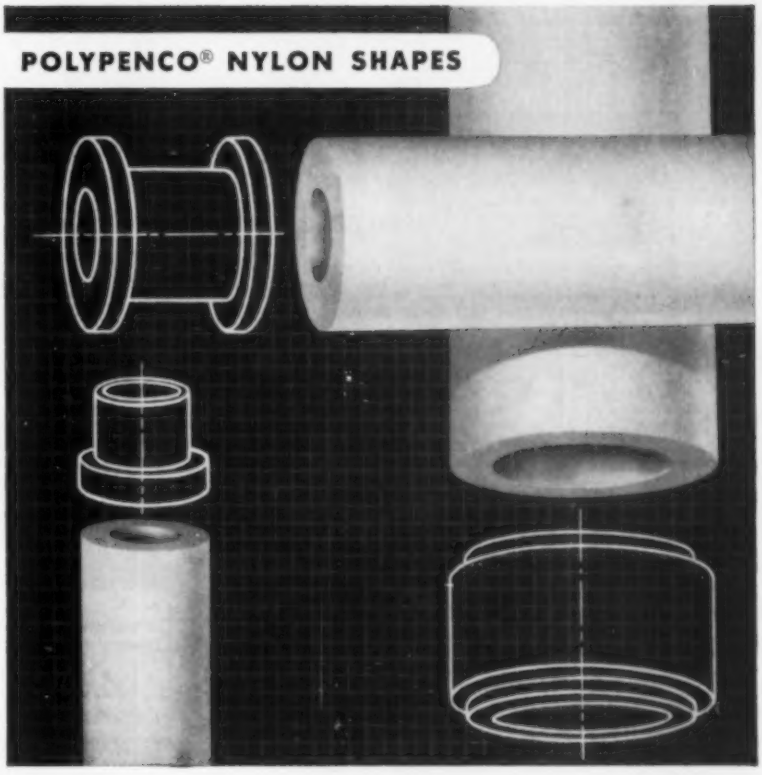
A $5-million ball-bearing plant will be built by Link-Belt Co., in Indianapolis, Ind., to replace and increase the capacity of its present facility. Construction will begin this year and is expected to be completed in 1958. Full production of bearings at the new plant is expected in 1959. Initial employment of 600 persons is expected to expand gradually to about 1000. The new bearing plant is the second Link-Belt expansion in Indianapolis within a year. A new malleable iron foundry at the Ewart plant is expected to be completed before the end of this year.

AEC Establishes New York Library

The Atomic Energy Commission announced that a classified depository library has been established at it's New York Operations Office, 70 Columbus Ave., to serve the needs of access permittees and Commission contractors in the area. The library is the first of a number of such depositories planned for various regions of the country as part of the Commission's program to facilitate access by cleared personnel to classified technical information.

The documents in the library are for reference purposes only, however, information on the price and source of individual reports will also be available. Library users may request classi-

(Continued on page 509)



Design starts here . . .
with the proper nylon stock shape

• Here are tubular bars made of Polypenco nylon . . . produced to eliminate drilling operations, reduce stock costs per foot . . . manufactured under rigid controls to provide nylon with uniform density, controlled physical properties.

• Designers specify Polypenco nylon shapes because parts can be machined rapidly, at low cost, and to close tolerances . . . and because they have complete control over every phase of production, maintaining design flexibility.

Outstanding Properties

Nylon parts are wear resistant and resilient with an excellent strength to weight ratio. They provide low coefficient of friction requiring little or no lubrication—plus noise dampening and non-galling or abrasive characteristics. They resist most chemicals and have good electrical insulating properties.

Stock Shape with Wide Application

Polypenco nylon rod, tubular bar, strip and plate are available for quick conversion to parts such as gears, bearings, rollers, valve seats, thrust washers, wear strips, and many other applications in food and beverage industries, machine tools, etc. Stock is immediately available from warehouses throughout the country.

Fabricating Service

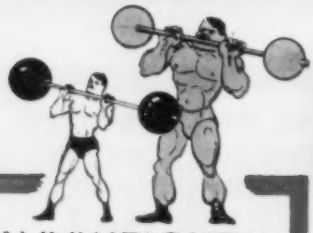
Custom fabricated parts are available from The Polymer Corporation of Pa., engineered for the best in design, quality and tolerances.

See POLYMER Booth No. 832
Design Engineering Show
New York City—May 20-23

THE POLYMER CORPORATION OF PENNA.
Reading, Penna.
Export: Polypenco, Inc., Reading, Penna., U.S.A.

POLYPENCO®

POLYPENCO nylon, POLYPENCO Teflon†, NYLAFLOW® and NYLATRON® GS †DU PONT TRADEMARK



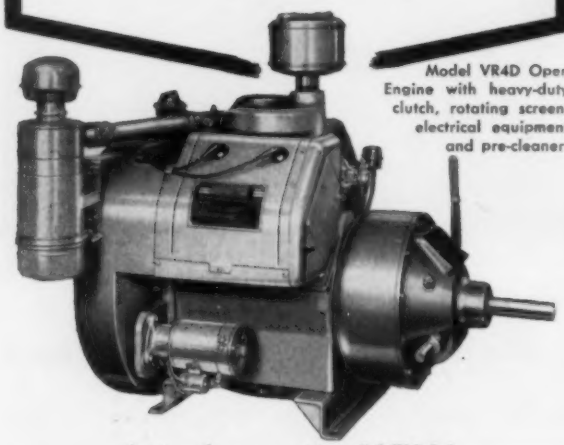
here's "HEAVYWEIGHT" power performance

in a light weight, man-size

WISCONSIN

Air-Cooled

ENGINE



Model VR4D Open Engine with heavy-duty clutch, rotating screen, electrical equipment and pre-cleaner.

Introducing the NEW

56 HP. Model VR4D

• Climaxing years of engineering development, this great new engine offers manufacturers and users of power equipment all the advantages of AIR-COOLING, at temperatures from low sub-zero to 140° F., in an exceptionally rugged engine that measures up to any "heavyweight" industrial type liquid-cooled engine, horsepower for horsepower, with many *plus values.*

The outstanding High Torque characteristic of the Model VR4D engine, combined with its extremely rugged construction and heavy-duty stamina, provide *load-lugging holding power,* long life and top power performance.

Advanced "V" design provides an extremely compact power package which includes all traditional Wisconsin heavy-duty features such as tapered roller main bearings plus additional new features.

This new engine rounds out a complete line, comprising 15 models in 4-cycle single cylinder, 2- and 4-cylinder sizes, from 3 to 56 hp. Write for "Spec" Bulletin S-207.

WISCONSIN MOTOR CORPORATION

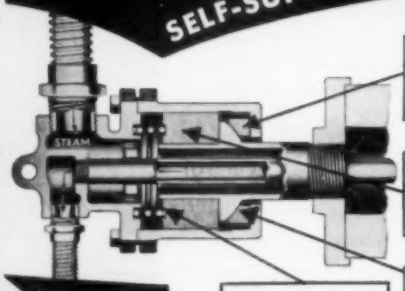
MILWAUKEE 46, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

A7-6092-½VA

JOHNSON Rotary Pressure JOINT

SELF-SUPPORTING TYPE



1. **SEAL RING** — of special carbon-graphite. Eliminates packing and oiling.

2. **GUIDE** — Also of carbon-graphite. Makes joint self-supporting.

3. **NIPPLE** — Rotates with roll, seals against ring.

4. **SPRING** — For initial seating only. In operation joint is pressure sealed.

Only 4 Internal Parts

For introducing steam and liquids into rotating rolls and cylinders, there's nothing like the Johnson Joint above. It's packless, self-lubricating, self-adjusting, self-supporting. It has been adopted by dozens of machinery makers, and is finding new uses every day.

Type SB shown handles both steam and condensate through same head; also available for through flow service, and in sizes and styles for all operating conditions. ***Write for literature.***

The Johnson Corporation

813 Wood St., Three Rivers, Mich.

New! BEAD CHAIN® DRIVES

Low-Speed, Positive Drives or Motion Transfer

. . . At Far Less Cost!

NOW—BEAD CHAIN—QUALIFIED FOR DRIVES

Swivel-like Bead Chain and special non-slip sprockets make any drive possible . . . at low cost . . . eliminates expensive gears, universal joints, etc. Perfect for inaccessible locations!

PULL CHAINS
RETAINER CHAINS
Kinkless
BEAD CHAIN
Chain of a thousand uses! Low cost, attractive, easy to use! 5 Sizes: 3/32" to ⅜". Strengths 20 to 200 lbs.
Write for FREE Catalog!
SUSPENSION CHAINS
DOOR CHECK
TAG CHAINS

THE BEAD CHAIN MFG. CO.

92 Mountain Grove St., Bridgeport 5, Conn.

Mr. Auburn says:

BY

AUBURN

For a quick and definitive solution to design and production problems, call on Auburn's 85 years of specialized experience in engineering materials to specific sealing and packing applications. Send us your prints and specifications — you'll get our recommendations and quotations promptly!

Our extremely wide range of materials includes:

Leather • Asbestos • Teflon • Silicone Rubber • Neoprene Rubber • Cork • Fiber • Compositions • Phenolics • Cloth • Paper • Cardboard • Plastics • Brass • Steel • Copper • Aluminum • Kel-F • Fibreglas • Other Special Materials.

GASKETS ALGCO PACKINGS

THE

AUBURN

MANUFACTURING COMPANY

306 Stack Street, Middletown, Conn.

Representatives: Atlanta, Ga. • Detroit Mich. • St. Louis, Mo. • Los Angeles, Cal. • Minneapolis, Minn. • Washington, D.C. • New York, N.Y. • Cincinnati, O. • Rochester, N. Y. • Pittsburgh, Pa. • Fort Worth Tex.

Visit Booth #212 at The Design Engineering Show

fied literature only in categories to which they have been granted access. Literature searches will not be performed, but bibliographic material, such as abstracts and indexes, will be available.

New Company in the Computer Field

The establishment of the Packard Bell Computer Corp., an affiliate of Packard-Bell Electronic Corp., has been announced. The new facility, located in West Los Angeles, has launched a research and development program in the digital computer field, to develop digital techniques and equipment.

Physics Project Laboratory Formed

A physics project laboratory has been established at the Westinghouse Research Laboratories, Pittsbugh, Pa., to expedite the development of electronic and related devices. The new laboratory will function on a project basis and will be concerned with a broad range of developments. Among the projects assigned to the new group is continued development of the image multiplier tube—a new type of electronic tube recently announced by the Laboratories. Using a new technique for the "multiplication" of electrons, the tube offers a method for strengthening weak radiations such as X-rays, infrared radiation and light.

The new laboratory will also be concerned with the immediate development of certain classified electronic projects for the Government. This will expedite the application of recent discoveries in the physics and electronics departments of the Westinghouse Research Laboratories.

Research Center to Study Spring Design

An expanded research and development program has been started by Associated Spring Corp., Bristol, Conn., with the two-fold purpose of improving its present products, precision mechanical springs and spring steel, and developing new products. A new research center is being estab-

(Continued on page 511)

MIDWEST MOLDS ALL 3 FOR ELECTRIC MOTORS

Precision-molded components in many stock sizes and types for building better motors . . .

Design engineers and production planners use MMM as a dependable source for all 3 motor parts; available stock dies permit some variations in finish and materials.

CAPS available in 100 or more sizes; over 50 HOLDERS; over 40 COMMUTATORS. MMM can build dies and custom-mold to specifications for all electrical applications of plastics.

ONE SOURCE FOR ALL 3 MOTOR COMPONENTS

Investigate this experienced producer as your supply source of ready-for-assembly units for your motors. Ask for MMM Stock Size Charts, or send prints for quotation.

Midwest Molding

& MANUFACTURING COMPANY

GURNEE 95 ILLINOIS

Chicago Phone: Dickens 2-0777

Long Distance: Ontario 2-1320

PLASTICS - TOOLING - COMPRESSION - INJECTION

71,400

reasons for looking into your opportunities at Chrysler Engineering

You can look forward, at age 30, to about 71,400 working hours to fill a normal life span.

Whatever the specific arithmetic that fits you, you'll want every hour to be spent profitably — for you, your family, and your career.

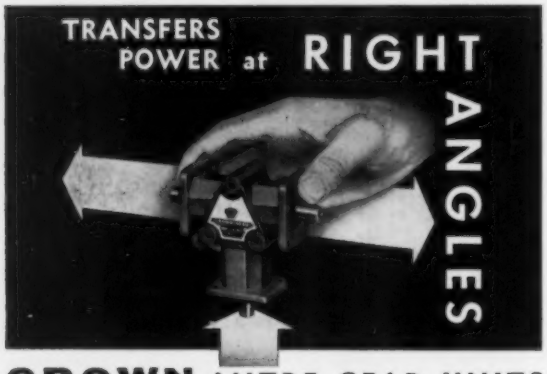
Here at Chrysler Engineering we can't promise the moon — too hard to deliver — but we do offer real advantages that may well be worth your thinking about.

First we're a team that respects ideas. Torsion-Aire Ride . . . push-button driving . . . Total-Contact Center Plane Brakes . . . these and many other automotive *firsts* began in the minds of Chrysler's creative engineers. Now we're busily exploring such exciting fields as nuclear power and solar energy, so the need for ideas today is greater than ever before.

Then you'll find flexibility and freedom here at Chrysler. Good pay. People you enjoy working with. Fine opportunities to advance, and something extra for the outstanding job. A real chance to learn more at the famed Chrysler Institute of Engineering and Detroit's many other graduate programs. And, of course, you'll be working right beside men who are authorities in the field.

Get all the facts by writing to Mr. L. C. Bettega, Chrysler Corporation, Engineering Division, P. O. Box 1118, Detroit 31, Michigan. There's no better time to do it than now.

CHRYSLER Corporation
ENGINEERING Division
P. O. BOX 1118, DETROIT 31, MICHIGAN



CROWN MITRE GEAR UNITS

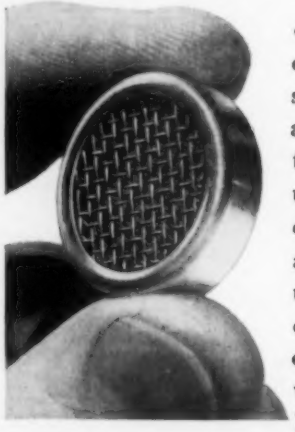
. . . are an ideal solution to all types of right angle needs, and are especially adaptable to confined areas. They're small, rugged, quiet, and precision made. Crown Gear Units have matched "Zerol" hardened gears which are mounted in double shielded ball bearings, and completely enclosed. Re-lubrication, if necessary, is easily accomplished, and four or five mounting flanges provide easy installation.
Special models will be engineered and quotations submitted for any specific problems. Write today for the name of your local distributor. Crown Gear Units are available almost everywhere. Write for engineering details.

CROWN GEAR
a division of Harrington & Richardson, Inc.
320 PARK AVENUE, WORCESTER 10, MASS.

Over 120 leading distributors in 43 States
Sold in Canada by H. R. Arms Co., Ltd., Montreal 23, P. Q.

NEW FILTER DISC

screen disc cartridge for service as breather or flame arrester



• A new filter disc incorporating wire cloth screen as filter media is available for application to many types of products. Completely self-contained, for simple adaptation to any product design, the filter disc serves as a breather or can be used as a tank vent flame arrester. Filter media is multiple layers of fine mesh steel or bronze wire screen. Available in 1", 1⅜", 1⅝", 3½" diameters. Write for complete information. **AIR-MAZE CORPORATION**, Dept. H, Cleveland 28, Ohio.

lished at the Corporation's headquarters in Bristol, which will more than double the company's research facilities and staff. The new center will be completely equipped with the testing and analytical devices required for research in mechanical and metallurgical engineering. In addition to this metallurgical analysis and production-engineering research, the new program will undertake fundamental research on mechanical actuation and other basic principles of spring design.

Research Building for Ball Bearings

A new research facility at The Barden Corp., Danbury, Conn., manufacturer of precision ball bearings, has been completed. Facilities in the new building include humidity and temperature controlled chambers, assembly rooms, machine shop, metallurgical laboratory, and engineering and drafting offices.

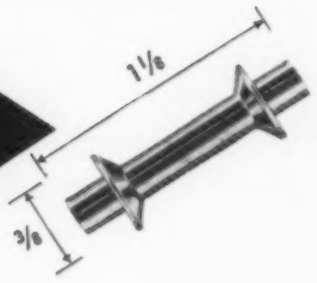
Product and Process Lab For GE

Construction of a new product and process development laboratory and further expansion of other facilities of the Silicone Products Department of the General Electric Co. have been announced. Expected to be ready for occupancy in January 1958, the laboratory is part of a $3-million capital

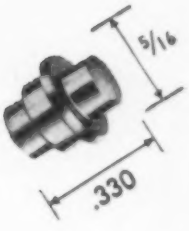
(Continued on page 513)

"You never looked at me that way!"

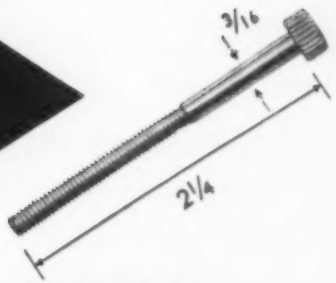
SAVINGS
$4.25
PER THOUSAND
over machine method cost



SAVINGS
$12.35
PER THOUSAND
over machine method cost



SAVINGS
$6.80
PER THOUSAND
over machine method cost



COLD-HEADING
SAVES YOU MONEY ON JOB-DESIGNED SMALL PARTS AND FASTENERS

Cold-Heading is the most versatile, most economical method for producing your fasteners and small parts. These case histories are typical of thousands of money saving jobs we've done for our customers. May we quote on your requirements? Write today for the Hassall Catalog.

John Hassall, Inc., P.O. Box 2233 Westbury, Long Island, N.Y.

Hassall

SINCE 1850

NAILS, RIVETS, SCREWS
AND OTHER COLD-HEADED
FASTENERS AND SPECIALTIES

This TRU-LAY PUSH-PULL DATA FILE

for Design Engineers will show you how these flexible remote controls are being used on hundreds of products to—eliminate complex, costly mechanical linkages . . . simplify design and assembly . . . improve appearance, operating characteristics and salability.

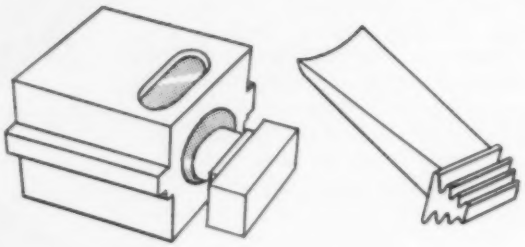
TRU-LAY
Send for this
USEFUL DATA FILE ON
TRU-LAY PUSH-PULL
It contains six engineering bulletins and booklets that will answer all your questions on the adaptability of these versatile and dependable remote controls.

ACCO

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

601-E Stephenson Bldg., Detroit 2
2216E South Garfield Ave., Los Angeles 22 • 929E Connecticut Ave., Bridgeport 2, Conn.

Hold irregular workpieces rigidly by nesting them in CERRO ALLOYS



The unique combination of low melting temperature and non-shrinking qualities in CERRO ALLOYS make them an excellent nesting matrix in jigs, chucks and fixtures for irregular shaped pieces. The illustration shows how a jet engine "pinetree" turbine bucket can be held snugly in a special fixture for grinding. After locating the bucket properly in the large cylindrical hole, the latter is filled with molten Cerro Alloy. After grinding the bucket, it is removed from the fixture by melting out the matrix in hot water. In such applications the low melting temperature of the Alloy eliminates all danger of annealing or burning the workpiece.

See you at the Design Engineering Show—Booth No. 1222

Send for further information.

CERRO DE PASCO SALES CORPORATION
52 E. 50th Street, New York 22, N. Y.

MILLIONS OF MOLDED, EXTRUDED, CUT RUBBER PRODUCTS IN STOCK

NATURAL HYCAR HYPALON
BUTYL SILICONE GR-S
NEOPRENE

Whatever your standard or custom needs, contact:

CAVELLE Rubber Company

422 N. Wood St., Chicago 22, Ill.
Representatives in Milwaukee, Minneapolis, St. Louis, Detroit and Dallas

Technical Handbook for engineers and purchasing agents NOW AVAILABLE

VELLUMOID

Proven Performance . . . Under Pressure!

Providing the exact gasket for so many vital applications has made Vellumoid materials first choice of design engineers in solving sealing problems.

Over 50 years experience as specialists is your assurance of quality gaskets of proven performance.

The Vellumoid Sales Engineer in your territory will gladly work with your engineering groups to assure you the correct gasket for your particular need.

THE VELLUMOID COMPANY
Worcester, Massachusetts

outlay planned for the Waterford, N. Y. plant during 1957.

The new, two-story research building will provide about double the space now available for laboratories and will be fully equipped for study of all aspects of silicone chemistry. The General Electric Research Laboratory at The Knolls, Schenectady, will continue its fundamental research in silicones.

Non-Ferrous Metal Lab Expanded

American Smelting and Refining Company is expanding its central nonferrous metal Research Laboratories at South Plainfield, N. J., by one-third. The Company's expansion has necessitated the addition of more than 20,000 sq ft of laboratory space. The new laboratories will be devoted to: asbestos application and process research, production and study of high purity metals, and research on refractory metals such as the rare earths and other high temperature metals. Construction will begin immediately, and full operation is expected by the end of the year.

Castings Plant Under Construction

A third plant which will increase the investment casting capacity of Austenal, Inc., is under construction at LaPorte, Ind., and will be completed by September. The facility is a two-story office building and a one-story production unit with a total area of 85,000 sq ft. Plant will start with approximately 300 employees, but has a potential of 700 employees. Other plants, including research, alloy manufacturing and general offices, are located in New York City, Dover, and Chicago.

New Group Formed to Improve Microwave Switching

The formation of a new research and engineering group for the study and improvement of high power microwave switching devices has been

(Continued on page 515)

do YOU use time delay relays?

Do you require ADJUSTABILITY? ... No Problem!
Do you require HERMETIC SEALING? ... No Problem!
Do you require BOTH? NO PROBLEM for the
A. W. HAYDON Company

The A. W. Haydon Co. offers a complete line of ADJUSTABLE — HERMETICALLY SEALED TIME DELAY RELAYS for operation under adverse environmental conditions

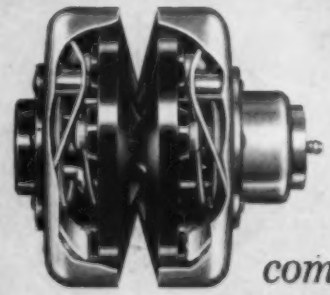
Write for Bulletin AWH TD401

Bulletin AWH TD401 Describes
6400 Series — DC units
11400 Series — AC units
24300 Series — 400 cycle units
Nominal Range of Adjustment: 8-1
Timers supplied with:
AN connector
Hermetic Adjusting Knob
Glass Window and Calibrated Dial

Illustrated above are a few of the many environmental conditions which these compact timers are designed to withstand. More rigid requirements frequently can be met upon special consideration.

The A. W. HAYDON COMPANY
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

DESIGN-WISE...



this simple pulley solves complicated problems

Compactness of HI-LO automatic variable speed pulleys simplifies basic machine design in a vast range of applications. The exclusive design of cam followers on cams provides simple, positive pitch diameter setting control. Springs in HI-LO pulleys are not driving members as in most spring-loaded pulleys, but serve primarily to keep the pulley faces in contact with the belt. Belt wear is reduced to a minimum because the belt is never under any more tension than is required by the load. Free technical manuals with diagrams, descriptions of applications and other power transmission data are available from:

Equipment Engineering Company
2855 Columbus Ave., Minneapolis, Minnesota Dept. 101

Seating Dollars Buy More at "Milsco"

- √ Complete engineering facilities
- √ Large, modern factory
- √ Field-tested seating for your satisfaction

NOW! The MILSCO "THRIFT-KING" SEAT IN **2** POPULAR SIZES AND STYLES

"THRIFT KING"

The Milsco "Thrift-King" seat is the nation's greatest seating value, and the demand has spread to the trucking industry, lift trucks, power mowers and many types of mobile equipment.

The strong welded angle iron frame in the "Thrift-King" has stood the test, and will add "sales-appeal" to your product.

MILSCO F-1105
Complete with folding backrest and padded with bonded foam rubber. Covered with brown Spanish grain Naugahyde. Fore and aft adjustment. Frame brown.
Front to rear . . . 19¼"
Left to right . . . 15⅜"

MILSCO F-1130
Complete with folding backrest and padded with bonded foam rubber. Covered with black imitation leather. Frame black. Center bar for easy attaching. Less fore and aft adjustment.
Front to rear . . . 19"
Left to right . . . 17⅜"

NOTE: "Thrift-King" seats can also be had with stationary backrest.

Write today for complete details.

AMERICA'S most versatile manufacturer of cushion seating . . .

Milsco MILWAUKEE

2756 No. 33rd ST., MILWAUKEE 45, WIS.

for highly corrosive fluids at pressures to 3000 psi
specify

Atkomatic STAINLESS STEEL solenoid valves

features include:

- Packless, globe type, two-way, pilot-piston operation
- Full ported design—½", ¾", 1", 1½" sizes.
- 316 stainless steel construction for maximum corrosion resistance.
- Resilient valve seats for bubble-tight, leak-proof seal.
- Instantaneous or delayed closing speed as desired.
- Single-wound "high pull" coil for pressures to 1500 psi; pressures to 3000 psi require double wound coil and relay.

Highly corrosive liquids and gases plus air, water and oil can be controlled safely and surely *even at 3000 psi* with Atkomatic Stainless Steel Solenoid Valves.

Solve your flow control problems Atkomatic-ly! Send for free 20-page Catalog No. 200-A.

Atkomatic VALVE CO., INC.
Dept. 4-F, 545 W. Abbott St., Indianapolis, Indiana

SOLVE YOUR
Packaging Problems with LERMER PLASTIC CONTAINERS!

Example:

E. R. Squibb & Sons desired a container which would dispense just one capsule at a time. LERMER engineers developed such a dispenser in record time . . . at a price far lower than thought possible.

Write for complete catalog.

LERMER Containers are:
- shatterproof, assuring long life.
- 75% lighter than glass, effecting enormous savings in shipping.
- available clear or opaque in a multitude of lustrous colors.
- can be handsomely decorated and printed during manufacture to carry your story.

LERMER PLASTICS, INC. 536 SOUTH AVE. GARWOOD, N. J.

REPRESENTATIVES IN THESE CITIES: Rochester, Philadelphia, Memphis, Miami, Cincinnati, Columbus, Cleveland, Chicago, Detroit, Minneapolis, San Francisco, Los Angeles.

PIONEERS AND SPECIALISTS IN PLASTIC CONTAINERS

announced by Microwave Associates, Inc., Burlington, Mass. The new group is working on fundamental research and engineering directed toward improved techniques and devices, particularly at high power levels. Dr. Lawrence Gould has been chosen to head the new department which at present consists of 10 engineers.

New Electronics Laboratory

An electronics plant for research in microwave physics and development of advanced radar and missile instrumentation will be constructed in Clearwater, Fla., by Sperry Rand Corp. The 75,000 sq ft laboratory will be built at an estimated cost of $2-million. The company will employ approximately 150 scientific and technical personnel.

West Coast Plant for Bearing Company

A new plant for Industrial Tectonics, Inc., Ann Arbor, Mich., has been opened in Compton, Calif. The new 30,000 sq ft plant will produce ball bearings for the aircraft and electronics industries, as well as guided missile and radar components. Currently 100 people are employed at the plant and it is expected that employment will reach 250 within the year.

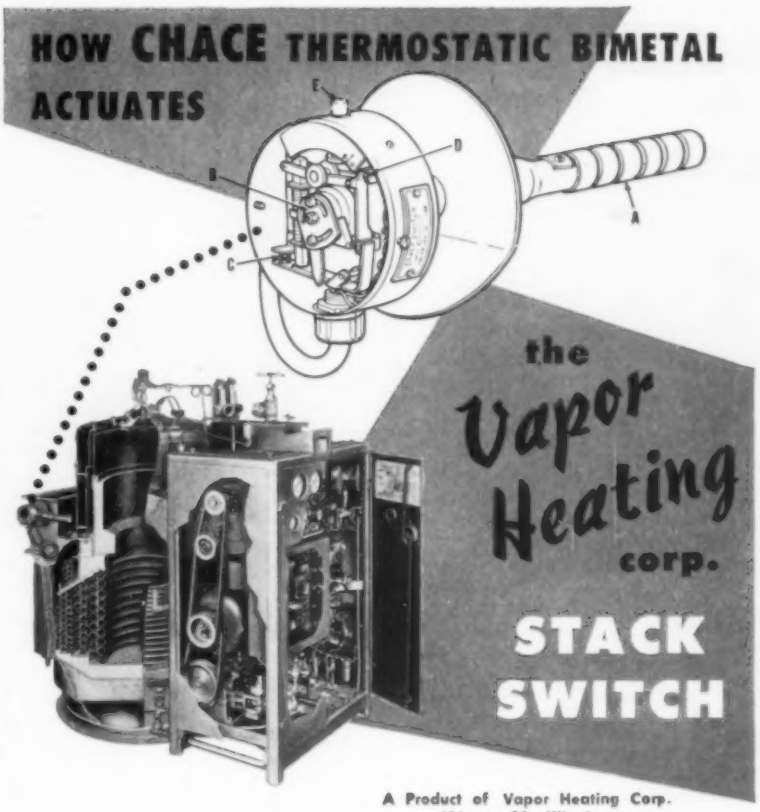
Supersonic Combustion Laboratory

Construction of a Supersonic Combustion Laboratory at the Fairchild Engine Div., Deer Park, N. Y., will be completed by May. The new research facility is an augmentation to the company's already operating Gas Turbine Research Laboratory. Upon completion of the new laboratory the initial project will be concerned with supersonic combustion research and experimentation in the fields of aerodynamics and thermodynamics.

Valve Research Laboratory

An expanded program of valve research and development has been announced by the Rockwell Manufacturing Co., Pittsburgh, Pa. Included

(Continued on page 517)



A Product of Vapor Heating Corp.
Chicago 31, Illinois

Thousands of Vapor-Clarkson Steam Generators are installed in Diesel locomotives to automatically produce high pressure steam used to heat the nation's Diesel powered passenger trains. One of the important safety controls which Vapor Heating Corporation developed for the steam generator is a reliable Stack Switch actuated by Chace Thermostatic Bimetal. This control is located in the exhaust stack of the steam generator and has two important functions: (1) to turn the steam generator OFF if the forced draft fire does not light up within 45 seconds from the time the switch is turned ON; and (2) to turn the steam generator OFF if the exhaust temperature becomes excessively high.

Here's how it works: the thermostatic bimetal helix (A) rotates a shaft attached to the indicator and cam (B). As the temperature of the exhaust in the stack increases, the bimetal flexes, turning the shaft to close switch contacts (C) at approximately 250° F., thus proving the presence of flame for combustion safety control.

If the exhaust temperature rises to approximately 900° F., the switch contacts (D) open, shutting down the steam generator. After correction of the condition which caused the high stack temperature and resetting this switch by resetting the button (E), the steam generator may be restarted.

Remember Chace when you design for temperature actuation or indication, or for protection of valuable equipment. Dependable Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data.

IT BENDS WITH THE HEAT
W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.

MARMAN Adjustable Band Clamps Hold Any Diameter Hose Securely

859 Series Band Clamp with T-bolt latch.

Marman Series 859 Hi-Strength Adjustable Band Clamps are recommended for hose, sleeve and cylinder clamping where diameter adjustment is a problem. Stainless steel band and T-bolt latch install quickly, resist vibration and corrosion. In three standard sizes for 1½" to 6" diameters; larger sizes made to your order. Write today for Bulletin B 2551-510.

Visit Marman Booths 727-729 (2nd floor), Design Engineering Show, May 20-23, New York

MARMAN DIVISION
Aeroquip Corporation

11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA
IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 10, ONTARIO

¡ES FACIL!

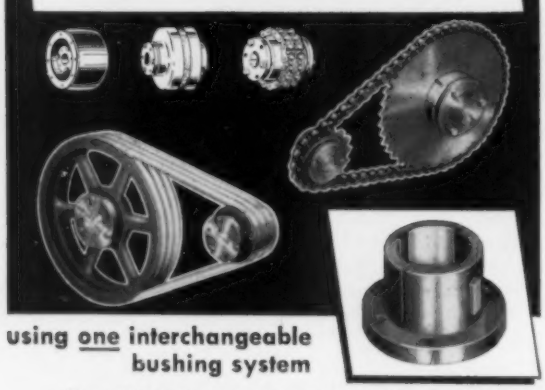
In Spanish, in English, in any language —it's easy to incorporate dependable, fool-proof timing into your product or its application. Rhodes can design and produce short or long runs of MARK-TIME mechanical timing devices to meet your every demanding specifications of performance and precision.

Let the manufacturers of the famous MARK-TIME timing devices help you solve timing application problems—send today for full details!

Representatives in principal cities in the U.S.
Manufactured and sold in Canada by:
Sperry Gyroscope Ottawa Ltd., Ottawa, Ontario, Canada

M. H. RHODES, INC.
547 BARTHOLOMEW AVE.
HARTFORD, CONNECTICUT

Browning THE ONLY COMPLETE POWER TRANSMISSION SERVICE



using one interchangeable bushing system

From this single source you can select the most efficient equipment for any power transmission need. For Browning manufactures an integrated line of sheaves and V-belts, sprockets and chain, paper pulleys, and couplings; all using Browning's exclusive *malleable* split taper bushing. Thousands of sizes and bores, off-the-shelf, ready to use. For information and free illustrated catalog GC101, ask Browning distributor or write to **Browning Manufacturing Company, Maysville, Kentucky.**

Browning POWER TRANSMISSION EQUIPMENT

JESSE JONES FILES

make Product Engineering an attractive, permanent part of your library

Two files hold copies from a full year's subscription. Rich maroon Kivar cover looks and feels like leather. Gold lettering.

Only $2.50 each, 3 for $7.00, 6 for $13.00, Postpaid. Add $1.00 postage for orders outside U.S. **Satisfaction or your money back!**

Send check or money order – or request that we bill you:

Jesse Jones Box Corp., Dept. P.E.
P.O. Box 5120
Philadelphia 41, Pa.

in the enlarged program will be work on automatic lubricators; hydraulic, pneumatic and electric valve operators; coated and high pressure valves; valves for vacuum service; improvement of test methods; and practical methods of producing vacuum-processed metals.

The valve research program will be augmented by a new valve laboratory and machine shop at the company's Central Engineering Headquarters in Pittsburgh. The new laboratory, double the original area, has been equipped for extended prototype proving.

East Coast Polyethylene Laboratory

To study high density linear polyethylene, W. R. Grace & Co.'s Polymer Chemicals Div., has selected Clifton, N. J., as the site for its main offices, customer application and research laboratories. Mr. T. T. Miller, Pres. of Polmer, said, "We believe Clifton, N. J. is an excellent location because over 50% of the plastics fabricators in the country are located in a 300-mile radius. Our service engineers are developing new techniques for molding and extruding polyethylene in rigid materials as well as film and

(Continued on page 519)

"There are some more changes he doesn't even know about yet."

NEED GEARS?
Eliminate "high-cost specials" by standardizing on
AMERICAN STOCK GEARS
Investigate and you'll probably find that instead of having to go to the added time and expense of ordering special gears, that your needs can be filled from the American line.
American is a 'complete' stock gear line. Manufactured by Perfection – a veteran of over 30 years in the gear business – these gears are made to the most precise standards, from the highest quality materials. This popular line includes brass, bronze, steel, semi-steel, cast iron, and non-metallic gears in a range of 48 to 3 diametral pitch.
You'll save time and money . . save on inventory . . . simplify purchasing and have less lost production time by procuring your stock gear needs from your nearby distributor of American Stock Gears.
Ask for FREE copy of American Stock Gear Catalog No. 360 containing detailed information and engineering data.
AMERICAN STOCK GEAR division
Perfection Gear Co., Harvey, Illinois

GREGORIO JARQUE and SON demonstrate the little sheave with the big grip

Easy on Bruce Jarque uses a standard wrench to assemble.

Easy off Two pull-up screws are used to break the cone grip.

Yet always tight on the shaft
Gregorio Jarque is no match for the QD Junior.

Exclusive tapered, split hub on Worthington QD Junior sheave grips the shaft so tightly it can't be dislodged

This two-piece, light-weight sheave has a heavyweight's grip. An exclusive tapered, split hub grips the shaft so tightly wrestler Gregorio Jarque can't dislodge it. Tests show the Worthington QD Junior will remain tight even under a torque force of 3300 pounds.

It's built for staying power—won't loosen or slip under shock or pulsating loads. Yet it's always easy to remove from the shaft.

Some other money-saving features of the QD Junior:

One Common Hub is standard for 54 stock sheave sizes, ranging from 3.2 to 18.4 inches pitch diameter.

Tapped Holes allow use of pull-up bolts as jack screws to break cone grip when removing rim from hub.

Heavy Hex Head Bolts fasten rim to hub. No special tools are required to remove or install the QD Junior. A standard hex socket wrench is all that's needed.

I-beam Arm (in larger sizes) gives more strength with less weight.

You'll find it's easy to select the proper light-weight sheave and FHP V-belt drive from bulletin FHP-100-B1A. Write for your copy today. Worthington Corporation, Section MV65, Oil City, Pa.

MV.6.5

WORTHINGTON

sheet almost every day." The company's Polymer Chemicals Div. was organized as the seventh chemical division of W. R. Grace & Co. in March of last year.

Research Lab to Study Ceramics

To permit expanded research into the properties, applications and improvement of high alumina ceramics, Diamonite Products Manufacturing Co., Canton, Ohio, has opened a research laboratory and a product development and pilot production plant. The company manufactures high alumina ceramic components for electronics, wear, corrosion, and heat-resistant parts. Located in a separate bay, the pilot plant is fully equipped for small-scale production, permitting greatly accelerated delivery of special shapes in limited quantities.

Research and Development Plant for Avco

Ground preparation for the $15 million research and development center of Avco Manufacturing Corp.'s Research and Advanced Development Division has begun in Wilmington, Mass. The permanent facility will serve all research and development programs of the corporation, and also undertake specific projects for private research laboratories and teams. The facility expected to be in operation by mid-1958 will consist of four integrated buildings for research, development, administration, and prototype testing and experimental manufacturing, providing more than 400,000 sq ft of floor space.

New Plant for Servomechanisms

Ground has been broken for the new Westbury, N. Y. plant of Servomechanisms, Inc., producers of electronic and electro-mechanical subsystems, computers and components. The new factory will be utilized for the design, development and manufacture of electronic control equipment, primarily for the aircraft and missile fields. The building, scheduled for completion this year, will

(Continued on page 521)

in the Spring . . .

■ A young man looks for high tensile strength, corrosion-resistance and close tolerances . . . especially if he is a design engineer who plans to incorporate the spring in his own machinery.

■ When you require springs, consult the spring engineers at John Chatillon and Sons. They have over 120 years of experience in designing and manufacturing all types of springs and they can solve *all* your spring problems.

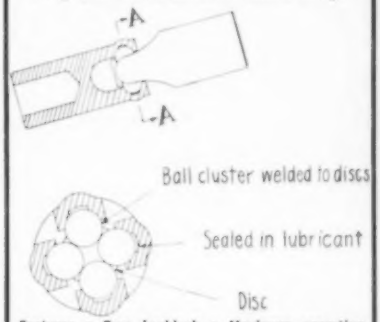
Send specifications and blueprints to Department D-1.

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N. Y.

Manufacturers of Precision Springs and Force Measuring Instruments Since 1835.

JOHN CHATILLON & SONS

MINI-JOINTS*
*Miniature Universal Joints with ZERO BACKLASH
for greater freedom in instrument design



Features • Zero backlash • Maximum operating angle of 30° • Lightweight • Sealed-in Lubrication

DIMENSIONS

Part NO.	ID	OD	OL	WGT.
SBS	SOLID	3/16	1-1/32	
1BS	.0938	"	"	.005
2BS	.125	"	"	"
3BS	.156	9/32	1-3/8	.013 #
4BS	.1875	"	"	"
5BS	.2188	3/8	1-3/4	.031 #
6BS	.250	"	"	"

(Also available as double joints)
Send for further information . . . available promptly on request.

FALCON MACHINE & TOOL CO., INC.
209 CONCORD TURNPIKE, CAMBRIDGE 40, MASS.

HOMMEL CERAMIC AND CERMET PROTECTIVE COATING

PROTECTIVE COATING FOR METALS SUBJECT TO HIGH TEMPERATURE

- RESEARCH
- DEVELOPMENT
- PRODUCTION

THE O. HOMMEL CO.
Dept. PE-557 PITTSBURGH 30, PA.
"THE WORLD'S MOST COMPLETE CERAMIC SUPPLIER"

A

AB

B

O

What Type American Are You?

It takes a lot of different types of people to make America what it is. And it takes different types of blood to make a blood bank . . . each as important as the other . . . each needed desperately.

Before the next 60 seconds have ticked away, four Americans will need blood to save their lives.

Give blood today . . . and save a life tomorrow!

the blood you give helps someone live!

GIVE BLOOD NOW

NATIONAL BLOOD PROGRAM

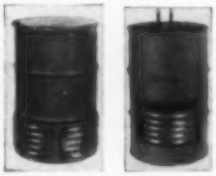
DEAN THERMO-PANEL COIL TAKES THE PLACE OF PIPE COILS

Not only does the Dean Thermo-Panel Coil TAKE THE PLACE of old-fashioned pipe coils, it does things that pipe coils can't do, or that they can do only at much higher cost. All product engineers should know that, almost invariably, the

DEAN. THERMO-PANEL COIL

costs less, weighs less, occupies less space, is more easily installed, is more efficient, more economical, and superior in every other way.

For example, here we show two Thermo-Panel Coil DRUM WARMERS. The one at the left is outside heated. The other is inside heated. To learn all about our Drum Warmers or Coolers — ask for Form DW-6.



If you want complete data on the Dean Thermo-Panel Coil, check one or both of the bulletins below. Clip out and send to us with your name, firm name, and address. If you need help, call on our specialists.

☐ *Bulletin 355. 52 pages. Technical Data.*

☐ *Bulletin 257. Price and Design Information.*

Backed by 20 Years of Panel Coil Manufacturing.

DEAN THERMO-PANEL COIL DIVISION
DEAN PRODUCTS, INC. 618 Franklin Ave.
BROOKLYN 38, N. Y. Tel. STerling 9-5400

memo:

McGRAW-HILL
TECHNICAL WRITING SERVICE

WRITES • EDITS
ILLUSTRATES
PRINTS

YOUR publications ...
to YOUR specifications

TWS relieves you of all or any of the many problems encountered in the production of your . . .

EQUIPMENT MANUALS – HANDBOOKS
PRODUCT CATALOGS–TRAINING AIDS
PAMPHLETS — REPORTS — BROCHURES
COMPANY HISTORIES — PARTS LISTS

150

WRITERS — EDITORS — ARTISTS
ARE AT YOUR SERVICE

WRITE:
Project Consultant
TWS—McGraw-Hill
330 W. 42 St. NYC 36
Phone: LOngacre 4-3000

occupy 55,000 sq ft of floor space. Facilities will be provided for expanded engineering, laboratory, model ship and precision production machine and assembly facilities.

West Coast Electronics Plant

Hughes Aircraft Co., Los Angeles, Calif., will proceed with plans to construct a $6 million electronics plant in Fullerton, Calif., before the end of the year. Present plans call for the erection of a 300,000 sq ft plant, half of which will be used for engineering and general offices, and the remaining half for electronics assembly work. Some 2000 personnel are expected to be on the payroll by the end of 1958.

New Divisions

Magnetics, Inc., Butler, Pa., has formed a Control Division to be responsible for design, manufacture and sales of high permeability magnetic devices for industrial control.

New Motion Pictures

All Films are 16 mm, color and sound.

"Switching to Safety"—20 min. The story of high reliability pressure switches used in the production of aircraft, missiles and industrial automobiles. Loaned free. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

"The Big Difference"—16 min. Shows the difference between types of castings and portrays testing procedures. This film may be previewed at booth 718 at the Design Engineering Show, New York Coliseum. Loaned free. Superior Steel and Malleable Castings Co., Benton Harbor, Mich.

"Modern Methods for Joining Metals" —20 min. Shows welding processes and applications in a non-technical manner. Linde Air Products Co., 30 E. 42 St., New York 17, N. Y.

"Short Run Stampings at Federal"—10 min. Shows methods of producing stampings and their application. Film may be seen at booth 1523, Design Engineering Show, New York Coliseum. Federal Tool and Mfg. Co., Minneapolis, Minn.

The Clentimack transmission is a variable speed transmission for the control of any process or machine requiring variable speed. Adjustments may be made manually or automatically over a complete range 8:1 — while the unit is at a standstill or in motion.

Clentimack

VARIABLE

SPEED

TRANSMISSION

Highly successful—proven in operation, these dependable transmissions are in use in many industries. A number of these units have operated continuously for five years without requiring maintenance or repairs.

For complete information, write:

GEORGE E. CLENTIMACK CO., INC.
229 WEST STREET, NORTH ATTLEBORO, MASS.

engineers and physicists

who want to LOCATE

locate (lō'kāt) *v.t.* **to place; establish;** *v.i.* **to settle**

Webster

Webster defines it . . . Farnsworth and Fort Wayne prove it!

If it is your desire ***to place*** yourself with an organization of superior competence in research, development and manufacture of military and industrial electronic systems . . . Farnsworth is for you! If you want to ***establish*** yourself with a smaller operating company backed by the reputation and stability of its giant parent, International Telephone and Telegraph Corporation — Farnsworth is for you!

If you want to ***settle*** in an uncrowded community known as America's Happiest City, located within easy driving distance of such cities as Chicago, Cleveland, Cincinnati, Detroit, Indianapolis, Louisville, St. Louis and Toledo — Fort Wayne is for you!

In short if you want to really LOCATE — ***to place*** yourself, ***establish*** and ***settle*** — find out about Farnsworth and Fort Wayne first!

Farnsworth

A DIVISION OF IT&T

ADDRESS:
Employment Director
Dept. PE-5

FARNSWORTH ELECTRONICS COMPANY, FORT WAYNE, INDIANA

a division of International Telephone and Telegraph Corporation

EQUIPMENT DESIGNER

Established expanding midwestern company looking for engineering graduate with experience in design of medium and heavy machinery. Qualified person would ultimately be in charge of newly formed department.

Knowledge of stress analysis of static and dynamically loaded members necessary. Nondestructive testing experience desirable but not necessary. Customer contact work will require limited amount of travel.

P-4779, Product Engineering,
520 N. Michigan Ave., Chicago 11, Ill.

REPRESENTATIVE WANTED

Manufacturer of J.I.C. boxes, cabinets and wireways wants qualified sales representative calling on O.E.M. accounts.

Reply to
RW-4763, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

DESIGN ENGINEERS

A progressive, rapidly expanding leader in the dynamic area of Integrated Data Processing and office automation has excellent opportunities for both mechanical product designers (electromechanical, small mechanisms) and machine designers (processing machinery). Products: business forms, mechanical devices and attachments, special office machines, electronic data processing equipment.

Send resumes to: Professional Employment, The Standard Register Co., Dayton 1, Ohio.

REPLIES (Box No.): Address to office nearest you c/o This publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

The University of Nevada at Reno, Nevada has openings on the teaching staff of the College of Engineering at the ranks of Instructor or Assistant Professor in Mechanical Engineering. Address Dean of Engineering for particulars.

EMPLOYMENT SERVICE

Mechanical Engineer design 8 years experience in design of small mechanical devices such as instruments automotive parts 30-45 fee paid 10,000. Edwards Employment Agencies, Inc., Executives-Engineers 73 Warren St., New York 17, N. Y. Barcley 6-3672.

SELLING OPPORTUNITY WANTED

Wanted: Manufacturer of engineered products who requires competent technical and sales representation; can provide well documented engineering experience and aggressive Sales Engineering concept; will cover West Coast Aircraft and Industrials according to your needs. A. H. Fink, Engineer; Suite 206, 9489 Dayton Way, Beverly Hills, California.

Don't forget

THE BOX NUMBER

when answering the classified advertisements in this magazine. It's our only means of identifying the advertisement you are answering.

ASSISTANT CHIEF ENGINEER

SALARY $13,500.00

Medium sized manufacturer of electro mechanical equipment has just completed a new plant. Report directly to the vice president of engineering of their new 800 man plant making some 50 standard electro mechanical items. Company client assumes all expenses. Contact in confidence.

MONARCH PERSONNEL
28 E. Jackson Chicago, Ill.

IBM growth promoted this man

Computer Programmer: Before his recent promotion, this man was a research programmer working with a giant IBM 704 electronic computer. He was engaged in the preparation of research problems of an engineering, scientific, business, and industrial nature for machine solution. His work entailed advanced diagnostic and application program development, including the modification of existing systems and proposed new systems. "This work has the same fascination as a game of chess," he'll tell you, "and the variety of constant challenges makes it absolutely absorbing!"

Could you handle his responsibilities?

Jobs like these continually open up at IBM—due to rapid expansion. If you are an engineer or scientist—or have equivalent experience—you may qualify for such a position. Innumerable opportunities exist in:

- Computer systems planning
- Computer systems testing
- Electronic circuit design and packaging
- Electrostatic phenomena
- Manufacturing process control
- Numerical analysis and programming
- Photo and magnetic device memory
- Real time systems engineering
- Semi-conductor research, development and manufacturing
- Test equipment design

For the facts about an engineering career with IBM, just write, outlining background and interests, to:

R. A. Whitehorne
Mgr. of Engineering Recruitment, Department 705
International Business Machines Corporation
590 Madison Avenue, New York 22, N.Y.

The electronic computer field offers one of the best ground-floor opportunities today. Economic experts rank it with automation and nucleonics in growth potential. Sales at IBM, the recognized leader in this fast-growing field, have doubled, on the average, every five years since 1930. Engineering laboratory personnel has quintupled in the past five years. IBM's excellent salaries and employee-benefit programs are instrumental in achieving an employee turnover rate far below the national average.

Where would you like to work for IBM?

IBM plants and laboratories are located in: Endicott, Kingston, New York City, Owego, Poughkeepsie, N. Y.; Burlington, Vt.; San Jose, Calif.; Washington, D. C.; Greencastle, Ind.; Lexington, Ky.; Rochester, Minn.; Sherman, Texas.

IBM DATA PROCESSING

DATA PROCESSING • ELECTRIC TYPEWRITERS • MILITARY PRODUCTS • SPECIAL ENGINEERING PRODUCTS • TIME EQUIPMENT

MECHANICAL ENGINEERS—

A challenging opportunity to create

A challenging future with a small growth company is offered the engineer who is interested in a career opportunity utilizing his training and technical know-how.

Responsible engineering positions exist in the machine design and development of xerographic equipment. Xerography, a process for forming and using electro static images, is widely used in the copying and duplicating fields. It is being developed for fascinating applications in automatic data processing, photography, office equipment, engineering drawing systems and interesting military applications.

Opportunities are available at all levels. There are openings also in product improvement and engineering standards work. Assignments are largely of the electro-mechanical type with a variety of optical, lighting, and electrostatic problems.

Previous experience in the design of office equipment or photographic equipment (military or commercial) would be helpful.

- **Comprehensive Employee Benefit Program**
- **Exceptional Tuition Refund Program**
- **Ideal living and recreational area**

HALOID

Kindly send resume and salary requirements to:

DAVID S. RAUB
Industrial Relations Division
THE HALOID COMPANY
Rochester 3, New York

Engineers

Mechanical or Electrical

BODINE

Leaders in fractional h.p. field
Offers Graduate Engineers
Interested in

Sales Application Engineering

Project Engineering

Development Engineering

The following advantages:
Secure & Prosperous Future
Challenging Work Assignments
Progressive Policies
Advancement Opportunities
Profit Sharing Plan

Reply in strictest confidence outlining particulars of education experience and personal data to

Personnel Director
Bodine Electric Co.
2500 W. Bradley Place
Chicago 18, Illinois

MECHANICAL ENGINEER

Recent graduate to work in Engineering office of medium sized chemical company, to work on plant layout, design of buildings and equipment. The Glens Falls area of about 30,000 population is ideally located near Lake George and other vacation areas. Progressive community with good schools and living conditions. Write Personnel Department, Imperial Paper and Color Corporation, Glens Falls, New York.

(2) PROJECT ENGINEERS
$10—12,000

With experience in Research, Design & Development of home appliances. Will head up group of designers & draftsmen & be responsible for completed product.

Send Resume or Call

J. J. COOPER
202 S. State—Suite 1116, Chicago, Ill.
Phone: Harrison 7-6337

Your inquiry will have Special Value

If you mention this magazine, when writing advertisers. Naturally, the publisher will appreciate it . . . but, more important, it will identify you as one of the men the advertiser wants to reach with this message . . . and help to make possible enlarged future service to you as a reader.

MECHANICAL ENGINEERS

Research and Development

Interesting positions open for mechanical engineers on a wide variety of projects in the following fields:

Mechanism Analysis
Machine Design
Servomechanisms
Experimental Stress Analysis
Vibration and Structural Dynamics

B.S. to Ph.D. in Mechanical Engineering with three to five years experience in one of these fields essential. These are permanent positions offering an opportunity to use your initiative and creative ability. We offer excellent employee benefits including tuition-free graduate study. For employment application, call Calumet 5-9600, or write

Mr. J. A. Metzger
ARMOUR RESEARCH FOUNDATION
of
Illinois Institute of Technology
10 West 35th Street **Chicago, Illinois**

What is *your* problem?

Competent men for your staff? . . . employment? . . . or are you looking for—or offering—a business opportunity of special interest to readers of this publication? You can get their attention—at small cost—through an advertisement in the Searchlight Section of ELECTRICAL WORLD.

SPECIAL SERVICE

Gears Designed. Also consultants on gear noise and gear life. Gear Consulting Service P. O. Box 12, University Station, Syracuse 10, New York.

WANTED

GENERAL MANAGER

Large, multi plant, metal working company wants a General Manager for one of its plants. Experience in metal fabricating techniques and machine shop operations is essential. A degree is required, preferably in engineering. The general manager will be responsible for manufacturing, engineering purchasing and other allied functions. Excellent opportunity for advancement to the position of V. P. for manufacturing. Send resume of educational and experience background to

P-4774—Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Index of

PRODUCTS ADVERTISED

In This Issue

A

Accumulators 109
Actuators
Mechanical 41, 290-291, 485
Adhesives 37-39, 69, 98, 222
Air Motors (see Motors, Air)
Aluminum Alloys...264-265, 287, 313-314 349, 525
Aluminum Coated Sheet and Strip (see Steel, Coated)
Assemblies
Electrical 463
Hydraulic 484
Pneumatic 441, 484
Axles 450, 457

B

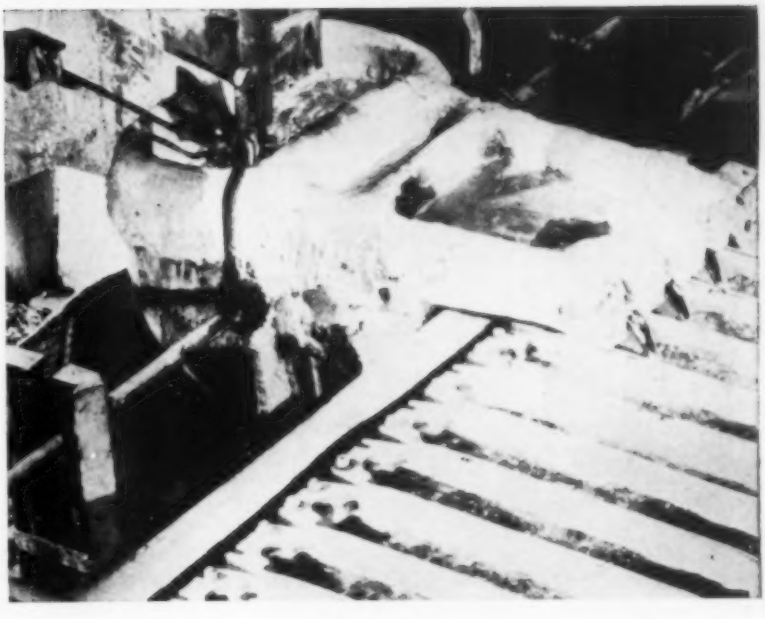
Balls 361, 506
Bars
Metal 4, 264-265, 324, 403
Non-Metallic 507
Bearings
Ball...46-47, 54, 77, 80-81, 108, 134, 249 267, 306, 328, 361, 488, 494, 506
Jewel 528
Miniature 134, 306
Needle 108, 116, 237, 249
Roller ..4th Cover, 46-47, 54, 77, 80-81 86-87, 108, 116, 237, 249, 306, 328
Self-Lubricating 311
Sleeve 324
Bellows 297, 396
Belts, Timing 16, 92
Belts, V.....13, 16, 37-39, 516, 518
Bi-Metal 515
Blowers 390, 487
Bolts 93, 258, 284-285, 350, 412
Books 486, 503
Boosters 109
Brakes
Electric 266, 497
Mechanical 266, 367
Pneumatic 367
Brass 349, 437
Brazing
Alloys 358
Bronze 309
Brush Holders 509
Brushes, Electrical 500
Bushings 324, 385, 509, 516

C

Cable 414
Cameras (see Photographic Equipment)
Cam Followers 116
Cams 292
Capacitors 259-260
Carbon 22-23, 500
Carbon Parts 422
Carburetors 502
Casters 504
Castings ...20-21, 276-277, 355, 384, 448
Castings, Centrifugal 448
Castings, Precision Investment..... 447
Catalog Services 18-19
Ceramics 494

Continued on p. 526

Federated Aluminum Alloys always conform to published Performance Specifications



If you have had reason to doubt the performance capacity of certain aluminum alloys, it will pay you to consult Federated before you re-design or substitute another metal.

Often the performance requirements of a part indicate that a certain aluminum alloy will do the job; yet in operation, the part fails. Costly re-design or a more expensive metal are usually relied upon to rectify the trouble.

All aluminum alloys should provide the characteristics set for them in published specifications. At Federated's three aluminum plants, rigid quality control insures that production ingot adheres exactly to specified content. Impurities are held at or below the minimum allowable percentage.

Every heat of every Federated aluminum alloy is tested exhaustively. Refining, alloying and testing techniques are under the supervision of ASARCO's Central Research Laboratory, where scientists can control metal impurities to parts per million, if required.

A Federated field man will be around to see you soon. Spend some time with him. It will benefit you.

Federated Metals

ASARCO

Division of

AMERICAN SMELTING AND REFINING COMPANY

120 Broadway • New York 5, N.Y.

Paragon® gives you speed ... without fatigue!

Check the response-to-the-touch. You can actually feel the difference!

That's why the Paragon Drafting Machine noticeably cuts end-of-the-day fatigue . . . saves costly man hours . . . helps raise working standards.

See how easily protractor control ring can be reached—no matter what position your hand is in. Another time saver. Touch that ring with your *little* finger and scales rotate freely. Release pressure and scales automatically lock to nearest 15° position. And intermediate angles are just as easily set!

Top day-to-day performance is guaranteed by unique "open center" design of arms which protects smooth-working factory-set band tension.

A good look at a Paragon and a touch on that control ring is worth 1,000 words! Try it before you buy *any* drafting machine—you can *feel* the difference.

89 YEARS OF LEADERSHIP

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

K+E KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles • Seattle • Montreal

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 525

Chains
- Bead 508
- Conveyor 15, 452, 505, 516
- Roller 15, 270, 439, 452, 505, 516
- Silent 15

Chemical Treatments 239, 263, 329

Chromium Alloys 88

Clad Metals 31, 360

Clamps 516

Clamps, Fixture 434

Clamps, Hose 366

Clips 132

Closures 389

Clutches
- Electrical 477
- Mechanical 257, 461, 477
- Pneumatic 257

Coatings ..98, 239, 263, 329, 494, 498, 519

Coils 360, 422, 521

Cold Headed Parts 350, 511

Commutators 509

Compressors 312

Connectors
- Hose 70-71
- Tube 70-71

Contactors 101-102, 421, 474-475

Contacts & Contact Materials ... 356, 450

Controllers 106

Control Panels & Switchboards 101-102, 426

Controls
- Electrical ..24-25, 78, 101-102, 106, 341 407, 421, 469-472, 501
- Electronic 101-102, 351, 394
- Hydraulic 339, 406, 436
- Mechanical 299, 488, 494, 512
- Pneumatic 381

Conveyor Belts 37-39, 348

Copper & Copper Alloys .43, 349, 437, 448

Counters 17, 486

Couplings (see Connectors, Electrical)

Couplings
- Electrical 74
- Hose 486
- Hydraulic 363, 425, 454
- Mechanical 6, 326, 363, 418, 516
- Tube 486

Cylinders
- Hydraulic ... 109, 276, 321, 406, 416, 467
- Pneumatic 109, 276, 321, 359, 381 416, 467, 506

D

Decalcomanias 390

Dials 426

Die Castings 275, 302

Dimmers 421

Drafting
- Instruments 122
- Machines 33, 58-59, 122, 526
- Supplies 33, 58-59, 415, 506, 526

Drives
- Adjustable Speed 74, 272-273
- Right-Angle 378, 510
- Shaft-Mounted 369
- Timing 16, 478
- Variable Speed ..... 3rd Cover, 119, 378 427, 446, 521

Index of

PRODUCTS ADVERTISED

In This Issue

•

E

Electrical & Electronic Components, Custom Made (see also Production Services) 333, 463, 509
Engine Indicators & Controls 105
Engineering Services (see also Production Services) 67, 220, 287, 362 414, 418, 426, 459-462, 503
Engines 325, 425, 454, 508, 527
Engravers 382
Expanded Metals 483
Extrusions
Metallic 309, 319, 368, 442, 448
Non-Metallic ... 256, 295, 336, 370, 415 507, 512

F

Fabricated Plastics (see Plastics, Fabricated)
Fabricated Steel (see Plate, Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)
Fabrics 320
Fastening Methods ... 60-61, 93, 107, 128 132, 235, 284-285, 335, 344, 370, 372 405, 511, 529, 532
Felt 455
Fibre 96, 110, 354, 395, 424, 512
Filters
Air 364, 441, 510
Hydraulic 332, 364
Fittings, Hose, Pipe & Tube 310, 451 476, 484, 537
Flexible Couplings 439
Flexible Shafts 301, 386, 400, 432
Floats 34
Forgings 288, 349, 368, 411, 448
Friction Materials 104
Furniture, Engineering Dept. 122

G

Gaskets 120-121, 375, 509, 512
Gear Motors (see also Motor Reducers) 114-115, 303, 307, 438, 464, 487, 493
Gears ... 11, 111, 119, 254, 261, 337, 376 378, 383, 401, 434, 443, 466, 517
Graphite 22-23, 429

H

Hard Surfacing 62
Heat Exchangers 397, 460
Heating Units 112, 473, 499
High Temperature Alloys 75
Hose & Tubing 70-71, 484
Hydraulic Fluids 347, 392

Continued on p. 528

Superior design, top performance, build a growing list of users for

KOHLER ENGINES

Short stroke • 4-cycle • Air-cooled

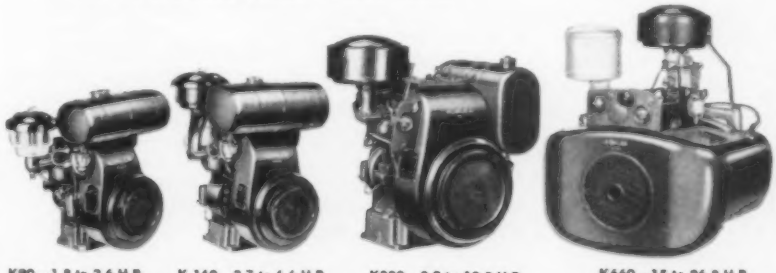
Superior design and performance have led to a steady increase in the use of Kohler Engines in every field of power equipment.

Precision-built to Kohler quality standards, Kohler Engines insure full-rated power in a wide range of sizes, with maximum response to heavy loads, remarkable low speed performance, snappy all-weather starting. Large bore and short stroke reduce engine friction and increase piston ring life, give utmost usable power. Fully anchored magneto has easily accessible outside breaker points. All models have liberal oil capacity—pressure lubrication on the K330 and K660. The K660 has tapered roller bearings at both ends of the crankshaft, smaller models have ball bearings at both ends. Sturdy, compact design provides low weight per H.P. output. Special silencer muffler and large capacity oil bath air cleaner reduce noise. Smooth, balanced operation minimizes equipment vibration, prolongs life.

Kohler branch offices are located in 16 principal cities. Sales and service organizations throughout the country have parts available. They will help you select a Kohler Engine best suited to your needs. Write for information.

Part of the growing list of Manufacturers using Kohler Engines:

Bolens Products Division, F.M.C., Port Washington, Wisconsin—Tractor
The Jaeger Machine Co., Columbus, Ohio—Centrifugal Pump
McDonough Power Equipment, Inc., McDonough, Georgia—Lawn Mower
Roof Mfg. Co., Pontiac, Illinois—Weed Mower
Hahn Inc., Evansville, Indiana—High Clearance Sprayer
Roto-Hoe & Sprayer Co., Newbury, Ohio—Tiller
Wm. Bros. Boiler & Mfg. Co., Minneapolis, Minnesota—Snow Blower
H. D. Hudson Mfg. Co., Chicago, Illinois—Sprayer
Wheel Horse Products Co., South Bend, Indiana—Tractor
Bachtold Bros. Inc., Forrest, Illinois—Weed Mower
West Fargo Mfg. Co., West Fargo, North Dakota—Elevator
Michaels Machine Co., Mattoon, Illinois—Weed Mower
Haban Mfg. Co., Racine, Wisconsin—Corn Detassler
Moll Tool Co., Chicago, Illinois—Concrete Vibrator



K90—1.8 to 3.6 H.P. K-160—3.7 to 6.6 H.P. K330—8.2 to 12.5 H.P. K660—15 to 26.8 H.P. (2 cylinder opposed)

Kohler Co., Kohler, Wisconsin • Established 1873

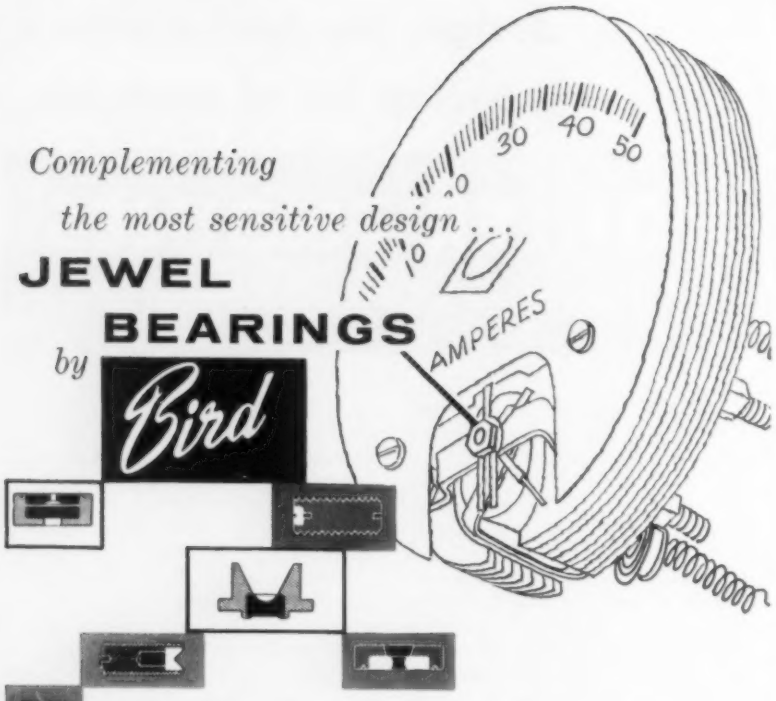
KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
AIR-COOLED ENGINES • PRECISION CONTROLS

Complementing the most sensitive design ...

JEWEL BEARINGS

by **Bird**



No matter how exacting the conditions,

***Bird* JEWEL BEARINGS ASSEMBLE MORE READILY and FUNCTION MORE EFFICIENTLY.**

A variety of settings and mounts, plus a wide range of sizes (stock sizes, or to specification), enables these high-precision elements to be ideally incorporated.

In addition, various settings and cushioning methods — silicon rubber, spring, or friction settings — provide maximum protection for bearings subject to severe shock conditions, yet permit controlled jewel movement, thus ending lost time for tear-down and readjustment.

Of particular advantage are the complete jewel assemblies, set in screws or bushings, which Bird provides in standard sizes or to your specifications. These assemblies greatly reduce overall cost by eliminating rejects, stopping waste, and cutting assembly time. Prove these advantages in your own plant. Forward a print to us with specifications — we'll provide you with testing samples.

For information on Bird Jewels write for Bulletin 14

Stringent quality control methods, exact tolerances and design features insure

- ✔ LASTING PRECISION PERFORMANCE
- ✔ LONGER INSTRUMENT LIFE
- ✔ VERSATILE ADAPTABILITY

Over 40 years of serving Industry with Quality Jewel Bearings

Richard H. Bird & Co., Inc.

SAPPHIRE AND GLASS JEWELS, PRECISION GLASS GRINDING, JEWEL MOUNTING AND ASSEMBLY, SAPPHIRE STYLI

1 Spruce Street, Waltham 54, Mass.

Index of PRODUCTS ADVERTISED

In This Issue

Continued from p. 527

I

Indium 280
Instruments
Mechanical 490
Insulation 117, 274, 323, 435, 509

J

Jewels 528

L

Lamps, Indicating 534
Laminated Metals 356
Laminated Plastics (see Plastics, Laminated)
Low Temperature Melting Alloys.... 512
Lubricants 66, 243, 291, 429, 504
Lubricating Equipment.....97, 119, 441

M

Magnesium Alloys 103
Magnetos 105
Manganese Alloys 88
Metal Bonded to Plastic..... 424
Metal Pre-Finished 360
Moldings
Glass (see Glass Parts)
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Motor Reducers (see also Gear Motors) 371
Motor Starters 101-102, 351, 474-475
Motors, A-C
Fractional...3rd Cover, 24-25, 33A & B 49, 99, 114-115, 124, 272-273, 282-283 296, 307, 357, 362, 398, 413, 431, 481 487, 489
Integral.....3rd Cover, 24-25, 33A & B 114-115, 272-273, 357, 362, 398, 413 431, 449, 481
Sub-Fractional 99, 124, 282-283, 390, 438 487, 489
Motors, Air 312, 359, 402
Motors, D-C
Fractional .....24-25, 33A & B, 49 67A & B, 99, 114-115, 124, 272-273 282-283, 307, 357, 362, 398, 413, 431 481, 487, 489
Integral ..24-25, 33A & B, 67A & B, 114-115, 272-273, 357, 362, 398 413, 431, 449, 481
Sub-Fractional....99, 124, 282-283, 390 438, 487, 489
Motors, High Frequency
Fractional 487
Sub-Fractional 487
Motors, Hydraulic 402, 406, 436

Index of

PRODUCTS ADVERTISED

In This Issue

•

N

Name Plates 390, 426, 488, 504
Nickel Alloys 2, 420
Nuts 89-91, 107, 284-285, 344, 412 495, 502, 529

O

Optical Parts 526

P

Packings ...37-39, 120-121, 245, 433, 509
Paper 308
Perforated Metals 394
Phosphor Bronze 491
Photographic Equipment Film 271
Pillow Blocks 46-47, 80-81
Pilot Lights 101-102, 351
Pins 51
Pipe 403
Plastic Parts 268-269, 333, 336, 340 370, 440, 514
Plastics 26-27, 251, 268-269, 279, 281 338, 340, 395, 479-480, 490, 498
Plastics, Fabricated....251, 336, 340, 395 440, 490, 507
Plastics Laminated 251, 345, 354, 395 424, 435, 440
Plates 4, 456
Porcelain 373
Powdered Metal Parts....8, 22-23, 37-39 83, 311, 324, 385
Power Take-offs 461
Pressure Switches 262
Production Machines & Processes 322, 383
Production Services (see also Engineering Services) 220, 333, 426 459-462, 463, 469-472
Pulleys 513
Pumps
Air 312, 402
Liquid 42, 315, 382, 388, 402, 406 436, 490, 492, 500, 536
Vacuum 312

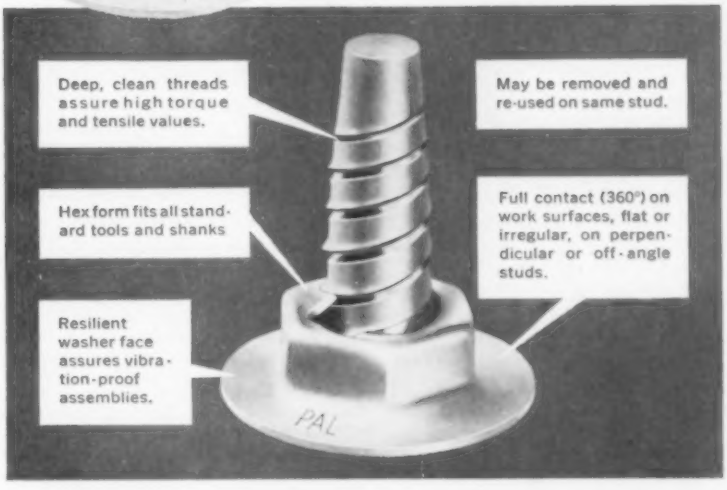
R

Recorders 289
Regulators
Hydraulic 339, 441
Pneumatic 381, 441
Relays....24-25, 83, 101-102, 218, 259-260 341, 407, 421, 444, 453, 465, 513
Reproduction Equipment ..33, 58-59, 526
Reproduction Supplies 33, 58-59, 271 415, 526
Resins ..26-27, 36, 268-269, 338, 377, 462
Resistors 259-260, 421

Continued on p. 530

New! PALNUT®
SELF-THREADING NUTS

Make their own threads on studs — easily, quickly


Deep, clean threads assure high torque and tensile values.
May be removed and re-used on same stud.
Hex form fits all standard tools and shanks
Full contact (360°) on work surfaces, flat or irregular, on perpendicular or off-angle studs.
Resilient washer face assures vibration-proof assemblies.
PAL

Ideal for Nameplates — Ornaments — Moldings with die-cast or cold-forged studs

Now . . . low-cost, plain studs become strong, vibration-proof threaded assemblies by simply fastening with the new PALNUT Self-threading Nuts. You eliminate the high cost of threaded studs—your fastening operation does the thread-cutting while tightening. No special tools needed—high-speed assembly is obtained with standard tools and methods.

PALNUT Self-threading Nuts are made of spring-tempered steel, comprising a thread-cutting lock nut and flat washer in one piece. Parts are pulled up tight with a resilient spring locking action that will not loosen in service. Available in sizes for $\frac{1}{8}$", $\frac{3}{16}$" and $\frac{1}{4}$" unthreaded studs. Write for free samples and descriptive literature.

Also available with "bonded-in" plastisol compound to seal out water and dust.

THE PALNUT COMPANY, 65 Glen Road, Mountainside, N. J.
Subsidiary of United-Carr Fastener Corporation

PALNUT® **LOCK NUTS** **FASTENERS** PAL®

Quick, secure fastening at low cost

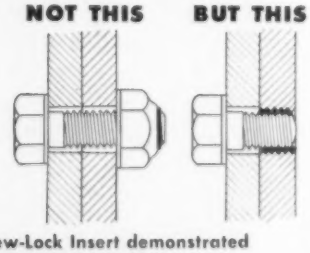
NOW—ALSO AVAILABLE IN 4-40 SIZE

Internal Lock Holds Screws Without Lock Wiring, Lock Nuts or Plate Nuts

Design and fastening problems are simplified with one-piece stainless steel *Heli-Coil* Screw-Lock Inserts, now available in 4-40 size. They protect the tapped hole, lock the screw without cumbersome external locking devices, meet Military specifications for impact and vibration even after repeated dis-assembly. Internal spring pressure prevents screw rotation.

Easily installed, Screw-Lock Inserts eliminate nuts, provide the answer to threaded fastening problems in miniature sub-assemblies.

Mail coupon for complete data.



See the *Heli-Coil* Screw-Lock Insert demonstrated at the Design Engineering Show.

HELI-COIL CORPORATION

*Reg. U.S. Pat. Off.

HELI-COIL CORPORATION
605 Shelter Rock Lane, Danbury, Conn.

- ☐ Send me complete design data on *Heli-Coil* Screw-Lock Inserts.
- ☐ Send design manual on standard *Heli-Coil* Screw Thread Inserts.
- ☐ Send "*Heli-Coil*," your case history periodical.
- ☐ Who is my local *Heli-Coil* Applications Engineer?

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____ 4634

IN CANADA: W. R. WATKINS CO., LTD., 41 Kipling Ave. S., Toronto 18, Ont.

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 529

Retaining Rings 79, 387
Revolving Joints 508
Rheostats 259-260, 421
Rings & Loops 126
Rivets ... 48, 107, 284-285, 405, 511, 532
Rod Ends 54
Rods
Metallic 309
Non-Metallic 336, 340, 345, 395, 415, 507
Rollers 500
Rubber 55, 130, 247, 256, 375
Rubber Parts 37-39, 76, 256, 295, 468, 512

S

Screw Fasteners 530
Screws 84, 89-91, 100, 113, 284-285, 350, 352, 495, 511
Screw Thread Inserts 530
Sealants 286
Seals ..... 2nd Cover, 37-39, 68, 120-121, 245, 278, 305, 342, 379, 391, 433, 506, 509
Seating Work Equipment 514
Shapes, Rolled Formed 304, 403, 419
Sheaves 516, 518
Sheets
Metal ... 4, 287, 327, 356, 360, 403, 408
Plastic 336, 340, 345, 395
Shims 428, 509
Silicones 117, 293-294
Silver Alloys 358
Slides 318
Solenoids 24-25, 32, 334, 422, 497
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) 48, 60-61, 107, 132, 235, 258, 344, 350, 412, 482, 495
Speed Reducers ... 44, 111, 119, 371, 378, 443, 461, 493
Spindles 450
Spinning 503
Splines 41, 485
Springs 94-95, 374, 417, 519, 535
Sprockets 15, 270, 439, 452, 516
Stampings 333, 337, 366, 374, 505
Steel
Alloy ... 35, 50, 56-57, 64-65, 88, 365
Carbon 56-57
Coated 28-29, 45, 365
Stainless 4, 28-29, 56-57, 88, 327, 330, 365, 384, 403, 408, 437
Textured 365
Tool 50
Strip, Metallic ... 4, 56-57, 231, 287, 327, 360, 403, 408, 515
Strip, Plastic 507
Structural Forms & Shapes 304, 448
Studs 350
Switches 40, 52-53, 101-102, 259-260, 298, 418, 430, 502

Index of

PRODUCTS ADVERTISED

In This Issue

•

T

Tachometers 289
Tantalum & Tantalum Alloys 346
Tapes, Insulating (see Insulation)
Templates 465
Terminals & Terminal Boards 63
Testing Machines & Equipment 316
Thermostats 30, 82, 118, 300
Timers 101-102, 404, 444, 501, 513, 516
Timing Motors 404, 444, 533
Titanium 346
Tracing Paper 33, 255
Transformers 422
Transmissions 521
Tubes 253, 309
Tubing
Flexible Metal 70-71, 393
Plastic 336, 340, 345, 395, 415, 507
Seamless 43, 50, 356, 538
Welded 14, 28-29, 253, 445
Tungsten Carbide 346

U

Universal Joints 399, 519

V

Valves
Air 1, 241, 252-253, 343, 381, 416, 441, 494, 498, 514
Control 416, 498, 500
Hydraulic 73, 97, 241, 343, 406, 409, 410, 416, 436, 486, 494, 498, 514
Solenoid 1, 241, 252-253, 331, 341, 343, 416, 514
Vibrators 531
Vibratory Equipment 316, 531

W

Washers 128, 284-285, 366, 372, 385, 495
Washers (see Packings)
Welding
Equipment 72, 317, 466
Nuts 498, 502
Supplies 72, 317
Weldments 126, 353
Wheels 450
Whiteprinting Equipment 380
Wire 4, 274, 333, 403
Wire & Cable 274, 356, 414
Wire Cloth 348, 458
Wire Forming 374
Wiring Devices 423
Wiring Harnesses 463

Z

Zinc Coated Sheets 45

FIGHT VIBRATION WITH VIBRATION

Now...shake-test to 5000 cps with 1750 lbs force!

HERE is an electrodynamic vibration exciter with highest operating frequency in its force range. The Model C10 VB exciter extends the range of vibration testing systems to 5000 cps with no table diaphragming or disturbing resonances under 5000 cps. Liquid cooled, it delivers up to 1750 lbs force output for continuous sinusoidal testing ... and extends the range of random motion testing to 5000 cps.

This exciter can be used with the MB Model T666 amplifier and TEMC control cabinet to subject specimens such as relays, electronic and control components through a wide range of vibratory frequencies to as high as 58 "g". Also, by the addition of the MB Model T88 complex motion console, it can be used for complex motion testing where specimens are subjected to the actual "noise" spectrum of the environment.

DESIGN ADVANCES

A UNIMODE rocker system (pat. pend.) restrains the 30 lb. moving table on its suspension. It assures linear motion over the total stroke of 1" (D.A.) – *continuous duty*. A packaged oil system and heat exchanger cool this equipment and permit its use in environmental chambers.

FOR OTHER NEEDS

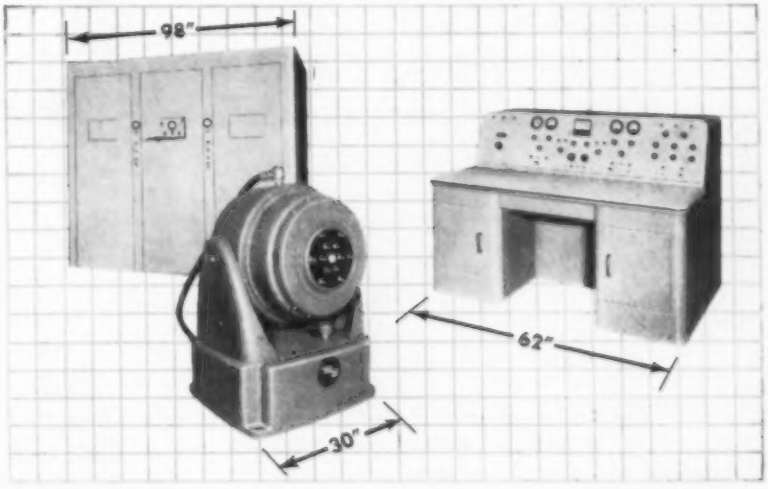
Present MB exciter ratings range up to 25,000 pounds force. Remember, too, that MB has a field service organization, including a Western office, ready to help you. Send for Bulletin 420-C.

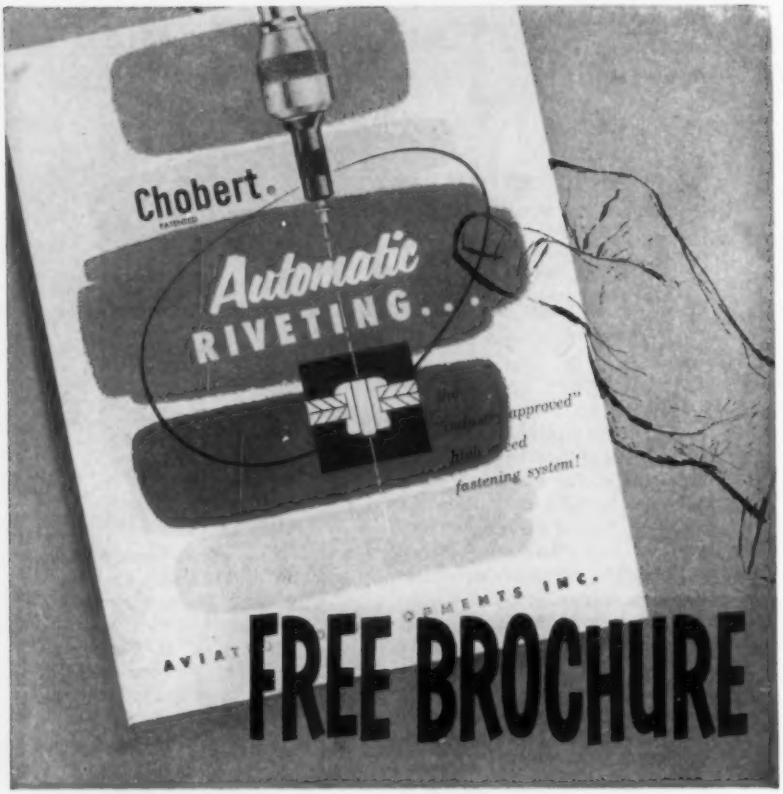
manufacturing company

A DIVISION OF TEXTRON INC.

1076 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE ... EXCITE ... AND MEASURE VIBRATION





tells how you can save time and money with

Chobert *Automatic* Riveting!

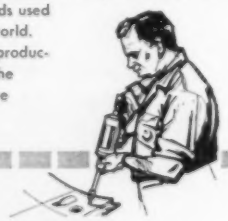
MOTOROLA TV—
cabinet assembly

HOTPOINT—
name plate attachment

NORTH AMERICAN AVIATION, INC.—
specialized application

Latest brochure tells how the Chobert High-Speed Automatic Riveting System works — shows typical blind and open applications where Chobert Automatic Riveting can save you time and money — all clearly illustrated and described. Types of rivets and their basic characteristics plus diagrams are included.

Photographs showing Chobert, "the industry-approved high speed fastening system" in applications covering a wide variety of Aviation, Transportation, Appliance, Architectural and other industrial and commercial uses will help you create new, efficient production shortcuts! Records show Chobert Automatic Riveting does the job faster, better and for less money than previous methods used by many major firms all over the world. Investigate the Chobert way to cut production costs—get your FREE copy of the Chobert Automatic Riveting brochure by sending coupon—TODAY!



HERE's the coupon—
Please send your FREE Brochure about Chobert Automatic Riveting right away!

AVIATION DEVELOPMENTS INC.
210 SOUTH VICTORY BOULEVARD • BURBANK, CALIFORNIA

NAME_____

TITLE_____ COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

PRESENT PRODUCTS_____

SEND REPRESENTATIVE ☐ SEND BROCHURE ONLY ☐

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

A

AMP, Inc. 423
Accurate Spring Mfg. Co. 374
Acheson Colloids Co. 429
Acme Chain Corp. 270
Acro Div., Robertshaw-Fulton Controls Co. 298
Acushnet Process Co. 468
Air-Maze Corp. 510
Ajax Flexible Coupling Co. 326
Alemite 97
Allegheny Ludlum Steel Corp. 330
Allen-Bradley Co. 101-102
Allen Mfg. Co. 113
Allied Research Products, Inc. 263
Allis-Chalmers Mfg. Co. 42, 474-475
Allis Co., Louis 272-273
Alloy Precision Castings Co. 447
Alpha Molykote Corp. 504
Aluminum Co. of America 264-265, 370
American Brass Co. 43
American Cyanamid Co., Plastics & Resins Div. 338
American Felt Co. 455
American Hard Rubber Co. 295
American Metal Hose Div., American Brass Co. 70-71
American Nickeloid Co. 360
American Smelting & Refining Co. 309
American Steel & Wire Div., U. S. Steel Corp. 56-57, 94-95, 403
American Welding & Mfg. Co. 126
Amforge Div., American Brake Shoe Co. 411
Ampco Metal, Inc. 448
Anchor Plastics Co., Inc. 415
Angier Adhesives Div., Interchemical Corp. 222
Apsco Products, Inc. 506
Arens Controls, Inc. 488
Armco Steel Corp. 4
Armstrong Cork Co. 69, 96
Arrow-Hart & Hegeman Electric Co. 407
Associated Spring Corp. 417
Atkomatic Valve Co. 514
Atlas Chain & Mfg. Co. 439
Auburn Mfg. Co. 509
Automatic Electric Sales Corp. 218
Automatic Switch Co. 341
Automatic Temperature Control Co. 501
Automotive & Aircraft Div., American Chain & Cable Co. 512
Aviation Developments, Inc. 532

B

Bakelite Co., Union Carbide & Carbon Corp. 26-27
Baldor Electric Co., Electric Motor Div. 398
Barber-Colman Co. 489
Barksdale Valves 241
Bead Chain Co. 508
Beaver Precision Products, Inc. 290-291
Bellows Co. 359
Bendix Aviation Corp., Eclipse Machine Div. 490
Bethlehem Steel Co. 93
Bird Co., Inc., Richard H. 528
Blood Brothers Machine Div., Rockwell Spring & Axle Co. 399
Bodine Electric Co. 124
Borg-Warner Corp. 459-462
Boston Gear Works 371
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co. 299
Browning Mfg. Co. 516
Bruning Co., Inc., Charles 33, 58-59
Buffalo Bolt Co., Div., Buffalo Eclipse Corp. 258
Bunting Brass & Bronze Co. 324

C

C & H Supply Co., Metal-Cal Div. 488
Calidyne Co. 316
Cambridge Wire Cloth Co. 348
Carpenter Steel Co. 75, 420
Carpenter Steel Co., Alloy Tube Div. 14
Celanese Corp. of America, Chemical Div. 392
Central Foundry Div., General Motors Corp. 20-21
Century Electric Co. 413
Cerro De Pasco Corp. 512
Cessna Hydraulics 492
Chace Co., W. M. 515
Chase Brass & Copper Co. 437
Chattillon & Sons, John 519
Chicago Rawhide Mfg. Co. ..... 2nd Cover

Chrysler Corp., Enginering Div..... 510
Chrysler Corp., Industrial Engine Div. 425
Ciba Co., Inc., Plastics Div..... 377
Clare & Co., C. P..... 453
Clark Controller Co..... 465
Clearprint Paper Co..... 255
Clentimack Co., George E..... 521
Cleveland Cap Screw Co..... 350
Cleveland Worm & Gear Co..... 119
Cold Metal Products Co..... 231
Columbia-Geneva Steel Div., U. S. Steel Corp. 403
Columbia Steel & Shafting Co., Summerill Tubing Co. Div..... 538
Commercial Shearing & Stamping Co. 406
Conax Corp. 500
Cone-Drive Gears Div., Michigan Tool Co. 443
Cooper Alloy Corp. 384
Cramer Controls Corp. 444
Crane Packing Co..... 340
Crown Gear, Subs. of Harrington & Richardson, Inc. 510
Crucible Steel Co. of America..... 408
Cuno Engineering Corp., Super Auto Klean Div..... 332
Cutler Hammer, Inc..... 351

D

Dana Corp. 457
Danielson Mfg. Co..... 476
Dean Products, Inc., Dean Thermo-Panel Coil Div..... 521
DeLaval Steam Turbine Co..... 111
Denison Engineering Co., Subs., American Brake Shoe Co. 436
Detroit Coil Co. 334
Detroit Stamping Co. 434
Diamond Mfg. Co. 499
Dings Brakes, Inc. 266
Dodge Mfg. Co.....46-47
Dormeyer Industries 422
Double A Products Co..... 73
Douglas Aircraft Co., Inc..... 496
Dow Chemical Co.....103, 279
Dow Corning Corp. 293-294
Dresser Mfg. Div., Dresser Industries, Inc..... 310
du Pont de Nemours & Co. (Inc.), E. I., Elastomers Div..... 247
du Pont de Nemours & Co. (Inc.), E. I., Polychemicals Dept.....479-480
du Pont de Nemours & Co. (Inc.), E. I., Textile Fibers Dept..... 110
Durakool, Inc. 418
Durant Mfg. Co..... 486
Durez Plastics Div., Hooker Electrochemicals Co....268-269
Dynamatic Div., Eaton Mfg. Co..... 74

E

Eagle Signal Corp..... 430
Eastern Air Devices, Inc..... 487
Eastman Kodak Co., Industrial Photographic Div..... 271
Eastman Mfg. Co..... 484
Eaton Mfg. Co., Reliance Div..... 128
Elastic Stop Nut Corp. of America.. 51
Electric Steel Foundry Co..... 355
Electric Wheel Co..... 450
Electro Metallurgical Co., Div., Union Carbide & Carbon Corp. 88
Elliott Co., Crocker-Wheeler Div... 449
Emerson Electric Mfg. Co..... 362
Emmert Mfg. Co. 122
Enjay Co., Inc. 130
Equipment Engineering Co..... 513
Erie Resistor Corp., Erie Electro-Mechanical Div..... 463

F

Fafnir Bearing Co..... 267
Fairbanks, Morse & Co., Industrial Div. 388
Fairbanks, Morse & Co., Magneto Div. 105
Fairfield Mfg. Co. 261
Falcon Machine Tool Co., Inc..... 519
Falk Corp. 369
Farrel-Birmingham Co., Inc..... 376
Fastex Div., Illinois Tool Works..... 335
Federal Mogul Div., Federal-Mogul-Bower Bearings, Inc. 385
Federal Tool & Mfg. Co..... 505
Federated Metals Div., American Smelting & Refining Co. 525
Fellows Gear Shaper Co..... 383
Fenwal, Inc. 82, 118
Ferguson Machine & Tool Co., Roller Gear Div. 478
Firestone Plastics Co., Chemical Sales Div., Div of Firestone Tire & Rubber Co. 36
Flexible Shaft Div., Robertshaw-Fulton Controls Co.... 301
Flexonics Corp. 396
Fluidwick Co. 243
Foote Bros. Gear & Machine Corp.... 378
Formed Steel Tube Institute 445
Formed Tubes, Inc. 253
Frenchtown Porcelain Co..... 494
Fulton Sylphon Div., Robertshaw-Fulton Controls Co..... 297

(Continued on p. 534)

BRISTOL MOTORS

For efficient, dependable control that results in famous Lathem Accuracy!

The Lathem Time Recorder Company of Atlanta, Georgia selected Bristol Motors over all others to control the timing devices that make Lathem Time Recorders outstanding for accuracy . . . accuracy that saves Lathem users valuable time and money!

The Bristol motor that answers the special needs of the Lathem Recorder is the Bristol High Torque model #444. No costly designing. And this motor successfully withstands shock, vibration, and other stresses. It also provides quiet, long-life operation. If seconds come first with you, too . . . see Bristol first!

BRISTOL MOTOR DIVISION
VOCALINE COMPANY OF AMERICA, INC.
107 COULTER STREET, OLD SAYBROOK, CONNECTICUT

14,000 G-E GLOW LAMPS KEEP 2,000,000 PEOPLE PER YEAR ON TIME!

Cleveland, Ohio—The flight information board at Hopkins Airport contains more than 14,000 G-E Glow Lamps that are turned on and off from a master control panel to form letters and numbers in lights. And although glow lamps are not primarily designed for lumen output, this board is easily readable from any spot in the spacious terminal. But—functional as this application might be . . . and dramatic as it is . . . General Electric Glow Lamps have many electrical characteristics that are stirring real enthusiasm in the electronic design field. So, consider G-E Glow Lamps for every live circuit in your design plans. General Electric Co., Miniature Lamp Dept., Nela Park, Cleveland 12, Ohio.

A Single G-E Glow Lamp May Serve As A:

RELAXATION OSCILLATOR • LEAKAGE INDICATOR

SWITCH • VOLTAGE REGULATOR • VOLTAGE INDICATOR

Progress Is Our Most Important Product

GENERAL ELECTRIC

INDEX TO ADVERTISERS

(Continued from p. 533)

G

Galland-Henning, Nopak Div. 416
Garlock Packing Co. 120-121
Garrett Co., Inc., George K. 366
Gast Mfg. Corp. 312
Gates Engineering Co. 498
Gear Specialties, Inc. 11
Geartronics Corp. 434
General Aniline & Film Corp., Ozalid Div. 380
General Controls Co. 331
General Electric Co., Apparatus Dept. ....24-25, 67A & B, 112, 289, 431
General Plate Div., Metals & Controls Corp. 31
Gibson Electric Co. 450
Gits Bros. Mfg. Co. 305
Gleason Works 6
Globe Industries, Inc. 438
Goodrich Co., B. F. 107
Goodyear Tire & Rubber Co. 13
Grant Pulley & Hardware Corp. 318
Grayhill, Inc. 502
Great Lakes Steel Corp., Div., National Steel Corp. 64-65
Gries Reproducer Corp. 302
Grip Nut Co. 502

H

Handy & Harman 358
Hannifin Corp. 467
Hansen Mfg. Co., Inc. 404
Harper Co., H. M. 284-285
Harrington & King Perforating Co. 394
Harrison Radiator Div., General Motors Corp. 397
Hartford Steel Ball Co. 506
Hassall, Inc., John 511
Haydon Co., A. W. 513
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 35
Heim Co. 54
Heinze Electric Co. 390
Heli-Coil Corp. 530
Hitemp Wires, Inc. 274
Holo-Krome Screw Corp. 84
Hommell Co., O. 519
Hoover Ball & Bearing Div. 361
Houghton & Co., E. F. 347
Howard Industries, Inc. 99
Howell Electric Motors Co. 464
Hunter Douglas Corp. 368
Hunter Spring Co. 535
Hyatt Bearings Div., General Motors Corp. 86-87

I

Illinois Gear & Machine Co. 401
Indium Corp. 280
Industrial Metal Protectives, Inc. 329
Ingersoll-Rand Co. 402
Inland Steel Co. 456
International Harvester Co., Industrial Power Div. 325
International Nickel Co., Inc. 9, 67
International Packings Corp. 245

J

Janette Electric Mfg. Co. 493
Jarvis & Jarvis, Inc. 504
Jeffrey Mfg. Co. 452
Johns-Manville Corp. 104, 278
Johnson Corp. 508
Johnson Machine Co., Carlyle 477
Jones & Laughlin Steel Corp. 319

K

KSM Products, Inc. 466
Kaiser Aluminum & Chemical Corp. 313-314
Kaydon Engineering Corp. 249
Kennametal, Inc. 346
Keuffel & Esser Co. 526
Keystone Carbon Co. 311
Kilian Mfg. Corp. 488
Kohler Co., Engine Div. 527
Koppers Co., Inc., Metal Products Div. 418
Kraissl Co., Inc. 410

L

L & L Mfg. Co. 486
Lamb Electric Co. 307
Laminated Shim Co., Inc. 428
Lavelle Rubber Co. 512
Leach & Garner Co. 356
Lehigh Chemical Co. 291
Leland Electric Co., Div., The American Machine & Foundry Co. 357

Lermer Plastics, Inc. 514
Lincoln Electric Co. 317
Linde Air Products Co., Div. of Union Carbide & Carbon Corp. 62, 72
Linear, Inc. 433
Link-Belt Co. 15, 77
Little Giant Vaporizer Co., Inc. 500
Long Manufacturing Div., Borg-Warner Corp. 460

M

McGill Mfg. Co., Inc. 237
McGraw-Hill Book Co., Inc. 503
McLouth Steel Corp. 327
MB Mfg. Co., Inc. 531
Mack Molding Co. 490
Madison-Kipp Corp. 275
Mahon Co., R. C. 353
Mallory & Co., Inc., P. R. 8, 40
Manhattan Rubber Co. 37-39
Marbon Chemical Div., Borg-Warner Corp. 462
Marlin-Rockwell Corp. 328
Marman Div., Aeroquip Corp. 516
Marsh Instrument Co. 490
Master Electric Co. ..... 3rd Cover
Mayer Co., George J. 504
Mead Specialties Co. 506
Mechanical Air Controls, Inc. 252-253
Meehanite Metal Corp. 276-277
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Meyercord Co., Name Plate Div. 390
Mica Insulator Co., Subs. of Minnesota Mining & Mfg. Co. 435
Michigan Tool Co., Cone-Drive Gears Div. 443
Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co. 52-53
Midwest Molding Mfg. Co. 509
Miller Co. 491
Miller Fluid Power Div., Flick-Reedy Corp. 109
Milsco Mfg. Co. 514
Miniature Lamp Dept., General Electric Co. 534
Minneapolis-Honeywell Regulator Co., Industrial Div. 262
Minnesota Mining & Mfg. Co. 98
Minnesota Rubber & Gasket Co. 342
Mobay Chemical Div., Monsanto Chemical Co. 281
Moraine Products Div., General Motors Corp. 83
Mosinee Paper Mills Co. 308

N

National Acme Co. 32
National Lock Washer Co. 387
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 68
National Tube Div., U. S. Steel Corp. 403
National Vulcanized Fibre Co. 354
Newark Wire Cloth Co. 458
New Departure Div., General Motors Corp. 134
New Hampshire Ball Bearings, Inc. 306
New Hermes Engraving Machine Corp. 382
New York Belting & Packing Co., Gilmer Timing Belt Div. 16
Nicholson & Co., W. H. 34
Norgren Co., C. A. 441

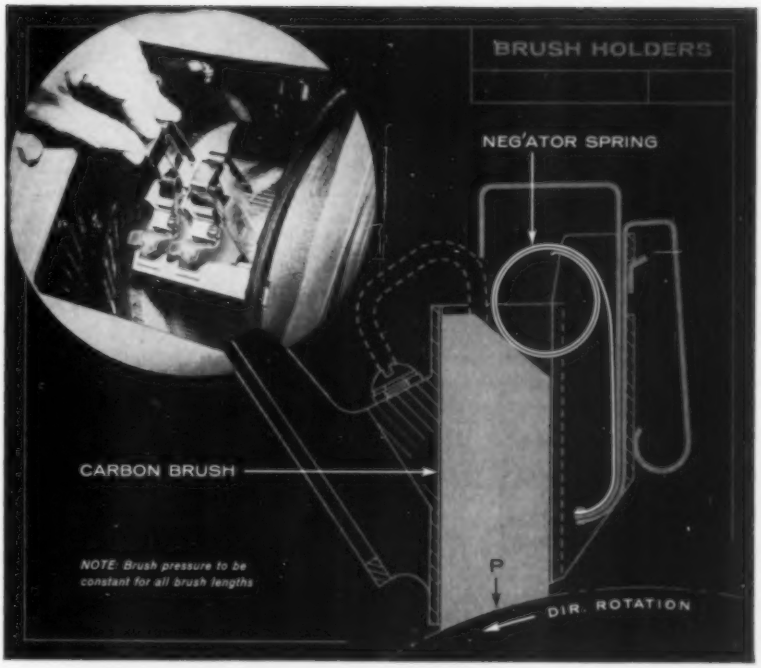
O

Ohio Carbon Co. 500
Ohio Nut and Bolt Co. 498
Ohmite Mfg. Co. 259-260
Onan & Sons, Inc., D. W. 454
Orange Roller Bearing Co., Inc. 116
Ortman-Miller Machine Co. 276

P

Pacific Automation Products, Inc. 414
Packard Electric Div., General Motors Corp. 49
Palnut Co. 529
Parker Appliance Co. 379
Parker-Hartford Corp. 292
Parker-Kalon Div., General American Transportation Corp. 100
Penn Metal Co., Inc. 483
Pennsylvania Flexible Metallic Tubing Co. 393
Perfection Gear Co., American Stock Gear Div. 517
Petch Mfg. Co. 451
Philadelphia Gear Works, Inc. 44
Pneu-Trol Devices, Inc. 498
Polymer Corp. of Penna. 507
Porcelain Enamel Institute, Inc. 373
Potter-Brumfield Mfg. Co., Div., American Machine & Foundry Co. 85
Precision Extrusions, Inc. 442
Precision Rubber Products Corp. 391

(Continued on p. 536)



Maintain Constant Pressure or Tension

USING A NEG'ATOR® SPRING

In the NEG'ATOR Constant-Force Spring, design engineers now have a mechanical component which will *maintain constant pressure or tension over all deflections.*

In vending apparatus, long NEG'ATORS are used to feed merchandise into dispensing position. In a belt grinder, NEG'ATOR Springs counterbalance a motor while keeping the drive belt taut. In a cam follower mechanism, a NEG'ATOR produces desired constant, minimum pressure. In motors and generators, NEG'ATOR Brush Springs keep pressure on carbon brushes at a constant, optimum value to compensate for brush wear.

As illustrated, one of the many design features of the new General Electric Co. KINAMATIC* Motors and Generators are the new brush holders which incorporate NEG'ATOR Brush Springs. By utilizing NEG'ATORS, GE engineers gained the following: (1) unvarying optimum pressure between brush and commutators; (2) elimination of periodic manual adjustments of brush pressure; (3) elimination of spring "hang-up"; (4) a one-piece assembly which is simple to fabricate and easy to assemble into the equipment; (5) easy, one-hand brush removal and replacement without tools.

Wherever applied, NEG'ATOR Springs—used as extension members, long-running motors, as bands, clamps, or clips—have cut costs and improved products. Learn more about this new basic component. Request a copy of Bulletin 310N. Or, if you're interested in NEG'ATOR Brush Springs, write for Bulletin 310P.

*Trade Mark of the General Electric Company

HUNTER SPRING COMPANY

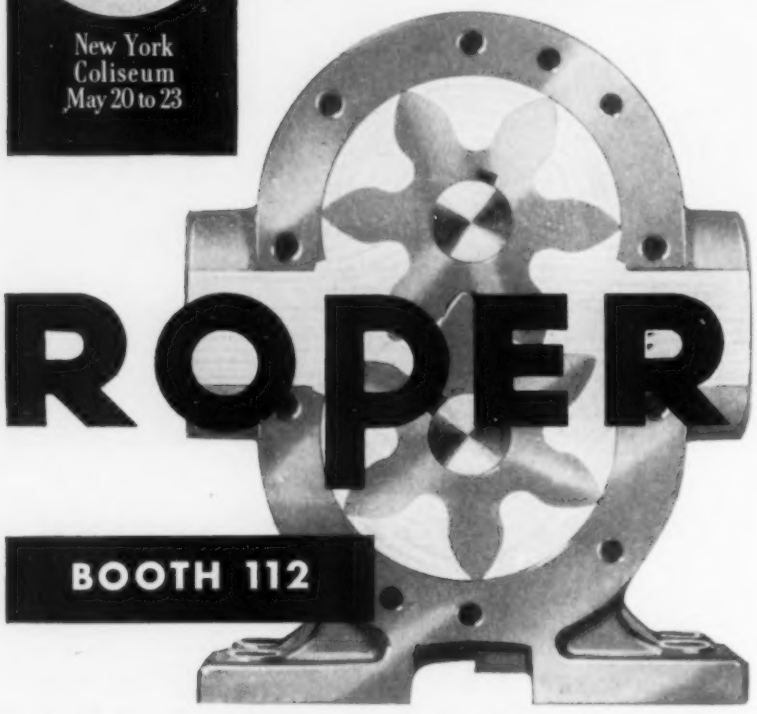
5 Spring Avenue, Lansdale, Pennsylvania

SPRINGS • STAMPINGS • TEST APPARATUS

Tomkins-Johnson Co. 321
Torrington Co., C. W. 503

1957 Design Engineering Show
New York Coliseum May 20 to 23

At the show...



ROPER

BOOTH 112

FIND OUT WHAT THESE PUMPING GEARS CAN DO FOR YOU!

STANDARD PUMPS — A large selection for hydraulic or processing equipment . . . pressure lubrication . . . fuel transfer . . . or you name it! Including all categories, you choose pumps in capacities from 5 to 300 GPM — pressures to 1000 PSI.

SPECIAL PUMPS — Many customers have effected great savings by having Roper modify a standard pump into a Roper "special" pump. A thorough analysis of your specifications will tell whether this is the practical approach to your requirements.

CUSTOM PUMPS — In these units, Roper employs the basic, tested principle of two equal size gears running in a precision fitted case. When the job is so complex only a custom pump will do, then depend on Roper to help you achieve the results you want.

NOT GOING? SEND FOR CATALOG 957

GEO. D. ROPER CORPORATION
375 Blackhawk Park Ave.
Rockford, Illinois

ROPER Rotary Pumps

INDEX TO ADVERTISERS

(Continued from p. 535)

Presstite-Keystone Engineering Products Co., Div., American-Marietta Co. 286
Prestole Corp. 344
Process Gear Co., Inc. 466
Protective Closures Co., Inc. 389
Purolator Products, Inc. 364

R

Racine Hydraulics & Machinery, Inc. 339
Raybestos-Manhattan, Inc. 37-39
Equipment Sales Div.
Manhattan Rubber Div.
Packings Div.
Raybestos-Manhattan, Inc.
Manhattan Rubber Div. 37
Raybestos-Manhattan, Inc.,
Packing Div. 38-39
Reeves Div., Reliance Electric & Engrg. Co. 446
Reliance Electric & Engrg. Co. 427
Republic Mfg. Co. 494
Republic Steel Corp. 28-29
Revere Copper & Brass, Inc. 349
Reynolds Metals Co., Parts Div. 287
Rhodes, Inc., M. H. 516
Richardson Co. 440
Robbins & Myers, Inc. 282-283
Robertshaw Thermostat Div., Robertshaw-Fulton Controls Co. 300
Rockford Clutch Div., Borg-Warner Corp. 461
Rockwood Sprinkler Co., Ball Valve Div. 409
Rogers Corp. 251
Roll Formed Products Co. 419
Roper Corp., Geo. D. 536
Ross Operating Valve Co. 1
Rubatex Div., Great American Industries, Inc. 375
Russell, Burdsall & Ward Bolt & Nut Co. 412
Russell Mfg. Co. 320

S

SKF Industries, Inc. 80-81
Saginaw Steering Gear Div., General Motors Corp. 41, 485
Schrader's Son A., Div., Scovill Mfg. Co. 381
Servo-Speed Div., Electro Devices, Inc. 394
Set Screw & Mfg. Co. 352
Shakeproof Div. of Illinois Tool Works 372
Sharon Steel Corp. 365
Shell Oil Co. 66
Sier-Bath Gear & Pump Co., Inc., Gear Div. 254
Silicones Div., Union Carbide & Carbon Corp. 117
Simmons Fastener Corp. 60-61
Skinner Electric Valve Div., Skinner Chuck Co. 343
Smith Corp., A. O., International Div. 220
Smith Corp., A. O., Electric Motor Div. 114-115
South Chester Corp., Southco Div. ... 48
Southwest Products Co. 494
Sparta Mfg. Co. 370
Spaulding Fibre Co., Inc. 395
Speer Carbon Co. 422
Spencer Thermostat Div., Metals & Controls Corp. 30
Spray Engineering Co. 537
Square D Co. 63
Standard Pressed Steel Co. 89-91
Stanpat Co. 415
Stewart Corp., F. W. 432
Stewart Warner Corp. (Alemite) 97
Stilson Tool, Inc. 500
Stow Mfg. Co. 386
Summerill Tubing Co., Div., Columbia Steel & Shafting Co. 538
Sutton Corp., Inc., O. A. 296
Sweet's Catalog Service 18-19
Sylvania Electric Products, Inc., Parts Div. 333
Synthane Corp. 345

T

Taylor Fibre Co. 424
Tennessee Coal & Iron Div., U. S. Steel Corp. 403
Thomas Publishing Co. 486
Thompson-Bremer & Co., Subs. of American Machine & Foundry Co. . 495
Timken-Detroit Brake Co., Rockwell Spring & Axle Co. 367
Timken Roller Bearing Co. ..... 4th Cover
Timken Roller Bearing Co., Steel & Tube Div. 50
Tinnerman Products, Inc. 132

Tomkins-Johnson Co. 321
Torngren Co., C. W. 503
Torrington Co. 108
Townsend Co. 482
Trombetta Solenoid Corp. 497
Tru-Seal Div., Flick-Reedy Corp. 506
Turco Products, Inc. 239

U

Union Carbide & Carbon Co.
Bakelite Co. 26-27
Electro Metallurgical Co. 88
Haynes Stellite Co. 35
Linde Air Products Co. 62, 72
Silicone Div. 117
United-Carr Fastener Corp. 235
United Shoe Machinery Corp. 405
U. S. Electrical Motors, Inc. 303
U. S. Gasket Co. 336
U. S. Graphite Co.,
Div. of the Wickes Corp. 22-23
U. S. Radium Corp. 426
U. S. Rubber Co.,
Mechanical Goods Div. 76, 92
U. S. Rubber Co.,
Naugatuck Chemicals Div. 55
U. S. Steel Corp. 403
U. S. Steel Export Co. 403
U. S. Steel Supply Div.,
U. S. Steel Corp. 403

V

Veeder-Root, Inc. 17
Vellumoid Co. 512
Vickers, Inc.,
Div. of Sperry-Rand Corp. 315
Viking Pump Co. 382
Virginia Gear & Machine Corp. 44
Vocaline Co. of America, Inc.,
Bristol Motor Div. 533

W

Wagner Electric Corp. 481
Waldes-Kohinoor, Inc. 79
Waldron Corp., John 363
Wales-Strippit Corp. 322
Ward Leonard Electric Co. 421
Watlow Electric Mfg. Co. 473
Weirton Steel Co., Div.,
National Steel Corp. 45
Western Felt Works 256
Westinghouse Electric Corp.
33A & B, 78, 106, 323, 469-472
West Virginia Works, Connors Steel
Div., H. K. Porter, Inc. 304
White Mfg. Co., S. S. 400
Wichita Clutch Co., Inc. 257
Wiegand Co., Edwin L. 499
Wiggins Oil Tool Co., E. B. 454
Wilmot Engineering Co. 505
Winzeler Mfg. & Tool Co. 337
Wisconsin Motor Corp. 508
Worthington 518
Wyman-Gordon Co. 288

Z

Zenith Carburetor Div.,
Bendix Aviation Corp. 502

PRODUCT ENGINEERING
ADVERTISING SALES STAFF

Atlanta 3 . . . M. H. Miller, 1301 Rhodes-Haverty Bldg., Jackson 3-6951
Boston 16 . . . M. A. Williamson, Jr., 350 Park Square Bldg., Hubbard 2-7160
Chicago 11 . . . A. E. Meanor, R. W. Bruley, 520 N. Michigan Ave., Mohawk 4-5800
Cleveland 15 . . . A. T. Tischer, 1510 Hanna Bldg., Superior 1-7000
Dallas 1 . . . G. L. Jones, Jr., 901 Vaughn Bldg., 1712 Commerce St., Riverside 7-5117
Detroit 26 . . . P. B. Robinson, 856 Penobscot Bldg., Woodward 2-1793
Los Angeles 17 . . . H. L. Keeler, 1125 West Sixth St., Madison 6-9351
New York 36 . . . P. G. Weatherby, B. K. Adams, 500 Fifth Ave., Oxford 5-5959
Philadelphia 3 . . . D. G. Jones, Architects' Bldg., 17th & Sansom Sts., Rittenhouse 6-0670
Pittsburgh 22 . . . C. F. Leveroni, A. F. Tischer, 1111 Oliver Bldg., Atlantic 4707
St. Louis 8 . . . A. E. Meanor, 3615 Olive St., Continental Bldg., Jefferson 5-4867
San Francisco 4 . . . R. C. Alcorn, 68 Post St., Douglas 2-4600

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES..522-524
Equipment For Sale..... 524
Index to Advertisers begins on P 532
Products Index begins on P 525

Spraco full-cone, free-flow nozzle discharging 860 gpm at 5 psi. This photo was taken at 1/5000 sec. shutter speed . . . at this speed the pulsations of the pump are apparent in the spray pattern.

RADICALLY NEW!

full-cone FREE-FLOW *nozzles from* SPRACO

Spraco's totally new, full-cone free-flow nozzles have been specially developed for high capacity, low pressure installations where clogging is a problem and full-cone spray pattern a necessity. Streamlined internal vane construction, with maximum vane openings, offers minimal flow resistance, virtually eliminates clogging.

STANDARD MATERIALS — bronze, cast iron, or stainless steel. Or, to order from any cast, machineable material.

SPRAY CHARACTERISTICS — uniformly distributed full cone spray.

PIPE CONNECTION — 4″–8″.

CONNECTIONS — screwed or flanged.

APPLICATIONS — cooling towers, chemical processing, coke quenching, aerating and purifying water supplies, cooling ponds, packed towers, absorption towers, etc.

Spraco welcomes your spray nozzle problems. As a leading consultant to industry for over 42 years, we are at the forefront in special nozzle development.

Write today for free, 30-page nozzle catalog. A complete selection of standard nozzles are available from stock.

SPRACO NOZZLES

SPRAY ENGINEERING COMPANY
133 Central Street, Somerville 45, Mass.

HYDRAULICS in AUTOMATION

No place for down-time

that's why **CROSS** specifies HYDRALUSTER tubing exclusively!

Hydraluster tubing is carrying the vital load of hydraulic transmission in this 350 ft. Cross transfer machine. Hydraluster is there because *every* part and assembly has to be 100 per cent dependable. There is too much at stake for anything less.

Why does Hydraluster get the call? . . . because it is a revolutionary improvement over any previous type of hydraulic tubing. *Inside*, Hydraluster has a new type of tubing surface, very much like a gun barrel. This smoothness cuts friction and heat, and the result is higher power efficiency and lower reaction times. This new surface is also highly resistant to oxidation and scale . . . added protection for valves, pumps and meters.

Here we quote Mr. Ralph E. Cross, Executive Vice President of The Cross Company. "*We've used Summerill Tubing for years because we felt it was the best. And when Summerill topped even their best with Hydraluster, it was only logical that we go along with the improvement.*"

*Stations—104. Operations—265 drilling, 6 milling, 21 boring, 56 reaming, 101 countersinking, 106 tapping, and 133 inspection.

SAMPLES and SPECIFICATIONS: Examine Hydraluster right at your desk or board. Your name on company stationery will bring samples and specifications.

Summerill

Tubing Company Division-Columbia Steel & Shafting Co.

PITTSBURGH 30, PA. DEPT. NO. 5-11

District Offices: Buffalo • Chattanooga • Chicago • Cleveland
Dayton • Hartford • Los Angeles • Philadelphia • Pittsburgh • Milwaukee • San Francisco

3-POINT EASY-TO-USE READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalogs and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key numbers in the space indicated. Bulletins are described on pages 326-348.

To get more data about new Components, Materials and Parts fully described on pages 232-324, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T–Top; B–Bottom; R–Right; L–Left; TL–Top left; BL–Bottom left; TR–Top right; BR–Bottom right.

For specialized data . . . prices, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space allotted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 5-57

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

NEW PRODUCTS... Description of these new engineering materials appear on pages 232-324. Circle key number for more data

1—Nylon Insulation Batting
2—Brakes, 125 to 650 ft-lb Torque
3—Time Delay Air Valve
4—Dimetric Protractor
5—Self-Locking Socket Setscrew
6—Hydraulic System Pump
7—Rotart Hydraulic Actuator
8—All-Air Control Circuit
9—Lightweight Pump
10—Solenoid-Controlled Air Valve
11—Control Valve Actuators
12—Manual Pressure Regulator
13—Variable Volume Pump
14—Pilot-operated Four-Way Valve
15—Four-way Quick-dump Valves
16—Epoxy-impregnated Paper
17—Fluxless Aluminum Solder
18—Heating Element Is Sprayed On
19—Nylon Rod or Parts
20—Polysterene Molding Compound
21—Wood Veneer
22—Plastic Shim and Gasket Stock
23—Silicone Rubber Compounds
24—Urethane Rubbers
25—Fractured Race Ball Bearings
26—Leveling Jack
27—Adjustable Diameter Bearing
28—Nylon Bearing Liners
29—Self-Leveling Machinery Mount
30—Over Running Clutches
31—Relief-Type Lubrication Fitting
32—Automatic Leveler
33—Machine Mounting Pad
34—Hex Nut Allows for Misalignment
35—Diecast Flexible Coupling
36—Plastic Knobs
37—Constant Level Oiler
38—Air Suspension With Time Delay
39—Vibration Mountings
40—Threaded Control Knob
41—Blind Drive Rivet
42—Dual Gravity Float Traps
43—Plate-type Engine Oil Cooler
44—Graphite Rupture Disks
45—Printed Circuit Layout Tape
46—Telescoping, Oiltight Fitting
47—Printed Circuit Boards
48—Non-linear Potentiometers
49—Miniature Time Delay Relay
50—Right-Angle Octal Socket
51—Potentiometer Unlimited Phasing
52—Dry Power Supplies
53—Flexible Shaft Terminals
54—Connect Screw
55—Subminiature Potentiometer
56—Interval Timer
57—Environment-Resistant Connectors
58—Silicone Rubber Heating Tapes
59—High-Temperature Insulation
60—Illuminated Oiltight Pushbutton
61—Electric Motor Brake
62—Fuel Pressure Regulators
63—Bi-directional Stepping Motor
64—Indicator for Transducers
65—Miniature Indicator Light
66—Ultrasonic Transducers
67—Two-Pole Mercury Plunger Relay
68—Engine Control Panels

PRINT or TYPE your address before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	11	13	14	15	16	17	18-9	20-1
22-3	24-5	26-7	28-9	30	31	32	33	33a-b	34	35	36	37	38
T39	B39	40	41	42	43	44	45	46-7	48	49	50	51	52-3
54	55	56-7	58-9	60-1	62	63	64-5	66	67	67a-b	68	69	70-1
72	73	74	75	76	77	78	79	80-1	82	83	84	85	86-7
88	89-91	92	93	94-5	96	97	98	99	100	101-2	103	104	105
106	107	108	109	110	111	112	113	114-5	116	117	118	119	120-1
122	124	126	128	130	132	134	218	220	222	231	235	237	239
241	243	245	247	249	251	252	L253	R253	254	255	256	257	258
259-60	261	263	264-5	266	267	268-9	270	271	272-3	274	275	L276	R276
277	278	279	280	281	282-3	284	285	286	287	288	289	290	L291
R291	292	293-4	295	296	297	298	299	300	301	302	303	304	305
306	307	308	309	310	311	312	313-4	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334
335	336	337	338	339	340	341	342	343	344	345	346	347	348
349	350	351	352	353	354	355	356	357	358	359	360	361	362
363	364	365	366	367	368	369	L370	R370	371	372	373	374	375
376	377	378	379	380	381	T382	B382	383	384	385	386	387	388
389	L390	R390	391	392	393	L394	R394	395	396	397	398	399	400
401	402	403	404	405	406	407	408	409	410	411	412	413	414
L415	R415	416	417	T418	B418	419	420	421	L422	R422	423	424	425
426	427	428	429	430	431	432	433	T434	B434	435	436	437	438
439	440	441	442	443	444	445	446	447	448	449	L450	R450	451
452	453	L454	R454	455	456	457	458	459	460	461	462	463	464
465	T466	B466	467	468	469-72	473	474-5	476	477	478	479-80	481	482
483	484	485	L486	TR486	BR486	487	T488	BL488	BR488	489	L490	TR490	BR490
491	492	493	T494	BL494	BR494	495	497	L498	TR498	BR498	L499	R499	TL500
BL500	TR500	BR500	501	L502	TR502	BR502	L503	R503	T504	BL504	BR504	T505	B505
TL506	BL506	TR506	BR506	507	L508	TR508	BR508	L509	R509	BL510	BR510	511	TL512
BL512	TR512	BR512	T513	B513	L514	TR514	BR514	515	TL516	BL516	TR516	517	T519
BC519	BR519	TL521	R521	R525	L526	R527	L528	R529	L530	R531	L532	R533	L534
R535	L536	R537	538	C3	C4								

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105							

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS IN THIS ISSUE

106	107	108	109	110	111	112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127	128	129	130	131	132	133
134	135	136	137	138	139	140	141	142	143	144	145	146	147
148	149	150	151	152	153	154	155	156	157	158	159	160	161
162	163	164	165	166	167								

Card expires July 1

Send Information On How I Can Subscribe to PRODUCT ENGINEERING ☐

CIRCLE THESE KEY NUMBERS.....
FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS.....
FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS.....
FOR YOUR COPIES OF.....

USE THIS SPACE.....
TO INDICATE REQUIRED.....

69—Four-Pole Relay
70—Damping Device Uses Eddy Currents
71—Miniature Relay
72—Electromagnetic Miniature Clutch
73—Relay for Printed Circuits
74—Fluid Pressure Measuring Cells
75—Magnetic Line Voltage Regulator
76—Diaphragm for Up to 500 F
77—Solenoid-operated Clutch Motors
78—Low-torque Potentiometer
79—Temperature Probes
80—Teflon Insulating Tape
81—Cyclic Control
82—Miniature Switches
83—Electrical Stop Clock
84—Meter for Edge-Lighted Panels
85—Right-Angle Gearmotor
86—Air Line Filter-Lubricator
87—Power Supply for 28 v D-c
88—Vacuum-Tube Voltmeter
89—Heavy Duty Limit Switch
90—Terminal Blocks for 125-250 Amp
91—Low-Level Digital Voltmeter
92—D-c Motors and Generators
93—Photoelectric Light Projector
94—Miniature Rotary Selector Switch
95—Surface Temperature Transducer
96—Position Indicator Controller
97—Oscilloscope Displays 40 Signals
98—Shaft Coupling Kit
99—Ruler Has Nine Scales
100—Rotary Switch Template
101—Portable 5-in Oscilloscope
102—Wide-band Oscilloscope
103—Thermistor Appraisal Kits
104—Modular Oscilloscope
105—Mechanical Lead Holders

PRODUCTS ADVERTISED

NEW PRODUCTS . . .

NEW BULLETINS . . .

SPECIFIC DATA . . .

NEW BULLETINS . . . listed below are described

on pages 326-348. Circle key number for your copy.

106—Metal Powder Bearings and Parts, 23 pp. Bunting Brass & Bronze Co.

107—Lithium, 14 pp. American Lithium Institute

108—Brushes for FHP Equipment, 33 pp. National Carbon Co.

109—Light and Heavy Duty Wheels, 24 pp. Allied Wheel Products, Inc.

110—Drawn Cup Roller Bearings, 6 pp. Torrington Co.

111—Relief-Type Lubrication Fittings, 4 pp. Keystone Lubricating Co.

112—Waterproof Solenoid Coil, 2 pp. Jays Mfg. Co.

113—Aircraft-Type Swivel Joints, 12 pp. Barco Mfg. Co.

114—Two-Way Lock Nut, 12 pp. MacLean-Fogg Lock Nut Co.

115—Plug and Receptacle, 2 pp. Molex Products Co.

116—Temperature Control Valve, 4 pp. Sterling, Inc.

117—Electric Time Controls, 4 pp. Miller-Harris Instrument Co.

118—Quick-Release Pins, 4 pp. Aviation Developments, Inc.

119—Simplified Practice Recommendations, 14 pp. Department of Commerce.

120—Commercial Standards, 12 pp. Department of Commerce.

121—Vinyl Sheeting, 4 pp. Masland Duraleather Co.

122—Heaters and Heating Devices, 72 pp. General Electric Co.

123—Timing Device, 2 pp. M. H. Rhodes, Inc.

PRINT or TYPE your address before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	11	13	14	15	16	17	18-9	20-1
22-3	24-5	26-7	28-9	30	31	32	33	33a-b	34	35	36	37	38
T39	B39	40	41	42	43	44	45	46-7	48	49	50	51	52-3
54	55	56-7	58-9	60-1	62	63	64-5	66	67	67a-b	68	69	70-1
72	73	74	75	76	77	78	79	80-1	82	83	84	85	86-7
88	89-91	92	93	94-5	96	97	98	99	100	101-2	103	104	105
106	107	108	109	110	111	112	113	114-5	116	117	118	119	120-1
122	124	126	128	130	132	134	218	220	222	231	235	237	239
241	243	245	247	249	251	252	L253	R253	254	255	256	257	258
259-60	261	263	264-5	266	267	268-9	270	271	272-3	274	275	L276	R276
277	278	279	280	281	282-3	284	285	286	287	288	289	290	L291
R291	292	293-4	295	296	297	298	299	300	301	302	303	304	305
306	307	308	309	310	311	312	313-4	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334
335	336	337	338	339	340	341	342	343	344	345	346	347	348
349	350	351	352	353	354	355	356	357	358	359	360	361	362
363	364	365	366	367	368	369	L370	R370	371	372	373	374	375
376	377	378	379	380	381	T382	B382	383	384	385	386	387	388
389	L390	R390	391	392	393	L394	R394	395	396	397	398	399	400
401	402	403	404	405	406	407	408	409	410	411	412	413	414
L415	R415	416	417	T418	B418	419	420	421	L422	R422	423	424	425
426	427	428	429	430	431	432	433	T434	B434	435	436	437	438
439	440	441	442	443	444	445	446	447	448	449	L450	R450	451
452	453	L454	R454	455	456	457	458	459	460	461	462	463	464
465	T466	B466	467	468	469-72	473	474-5	476	477	478	479-80	481	482
483	484	485	L486	TR486	BR486	487	T488	BL488	BR488	489	L490	TR490	BR490
491	492	493	T494	BL494	BR494	495	497	L498	TR498	BR498	L499	R499	TL500
BL500	TR500	BR500	501	L502	TR502	BR502	L503	R503	T504	BL504	BR504	T505	B505
TL506	BL506	TR506	BR506	507	L508	TR508	BR508	L509	R509	BL510	BR510	511	TL512
BL512	TR512	BR512	T513	B513	L514	TR514	BR514	515	TL516	BL516	TR516	517	T519
BC519	BR519	TL521	R521	R525	L526	R527	L528	R529	L530	R531	L532	R533	L534
R535	L536	R537	538	C3	C4								

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105							

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS IN THIS ISSUE

106	107	108	109	110	111	112	113	114	115	116	117	118	119
120	121	122	123	124	125	126	127	128	129	130	131	132	133
134	135	136	137	138	139	140	141	142	143	144	145	146	147
148	149	150	151	152	153	154	155	156	157	158	159	160	161
162	163	164	165	166	167								

Card expires July 1

Send Information On How I Can Subscribe to PRODUCT ENGINEERING ☐

124—Polyphase Induction Motors, 4 pp. General Electric Co.

125—Pushbutton Stations, 8 pp. General Electric Co.

126—Motors for Single-Phase Applications, 8 pp. General Electric Co.

127—Clad Metals, 4 pp. American Silver Co.

128—Heat Sheets, 4 pp. Electrical Coatings, Inc.

129—Industrial and Decorative Laminates, 8 pp. Farley and Loetscher Mfg. Co.

130—Pumps and Pump-Motors, 12 pp. Geo. D. Roper Corp.

131—Speed Reducers, 24 pp. Falk Corp.

132—Coil Springs, 4 pp. Dudek & Bock Spring Co.

133—Set Screws, 24 pp. Set Screw & Mfg. Co.

134—Flexible Tubing, 16 pp. U. S. Flexible Tubing Co.

135—Resistance Measuring Bridges, 8 pp. Shallcross Mfg. Co.

136—Silicone Fluids, 4 pp. Dow Corning Corp.

137—Rotary, Mechanical Seals, 16 pp. Durametallic Corp.

138—Shear Pin Sprockets, 4 pp. Link Belt Co.

139—Silver Brazing Preforms, 14 pp. Lucas Milhaupt Engineering Co.

140—Gears and Pinions, 16 pp. Chicago Rawhide Mfg. Co.

141—Silicon Iron Magnetic Tapes, 4 pp. Thomas & Skinner, Inc.

142—Polyamid Tubing, 4 pp. Polymer Corp. of Pa.

143—Metal Thermostats, 2 pp. Stevens Mfg. Co., Inc.

144—Permanent Magnets, 12 pp. General Electric Co.

145—Aircraft Hydraulic Pumps, New York Air Brake Co.

146—Where to Use Aluminized Steel, 6 pp. Armco Steel Corp.

147—Solenoids, Coils and Electrical Components, 6 pp. Anderson Controls, Inc.

148—Gage Accessories, 4 pp. United States Guage

149—High Temperature Alloys, 20 pp. Carpenter Steel Co.

150—Clamps for Plastic Pipe, 2 pp. Wittek Mfg. Co.

151—Plug-In Counting Circuits, 4 pp. Walkirt Co.

152—Heat Treatment, 32 pp. Pittsburgh Commercial Heat Treating Co.

153—Right-Angle Bevel Gear Units, 4 pp. Airborne Accessories Corp.

154—Teflon Tubing, 2 pp. Polymer Corp. of Pa.

155—Door Operator Motors, 4 pp. General Electric Co.

156—Conversion Factors, Precision Equipment Co.

157—Conveyor and Elevator Belts, 21 pp. Raybestos-Manhattan, Inc.

158—Self-Tapping and Locking Studs, 4 pp. Pheoll Mfg. Co.

159—Reusable Hose Couplings, 12 pp. Alemite Div., Stewart-Warner Corp.

160—Driers, Filters and Valves, 8 pp. Remco, Inc.

161—Fasteners, 14 pp. Huck Mfg. Co.

162—Switches, 4 pp. Micro Switch

163—Sheaves, 4 pp. Allis-Chalmers Mfg. Co.

164—Grommet V Belts, 4 pp. Allis-Chalmers Mfg. Co.

165—Gaskets and Shims, 4 pp. General Gasket, Inc.

166—Lubricant for Bearings, 8 pp. Fluidwick Co.

167—Thread-Cutting Screws, 31 pp. Shakeproof

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

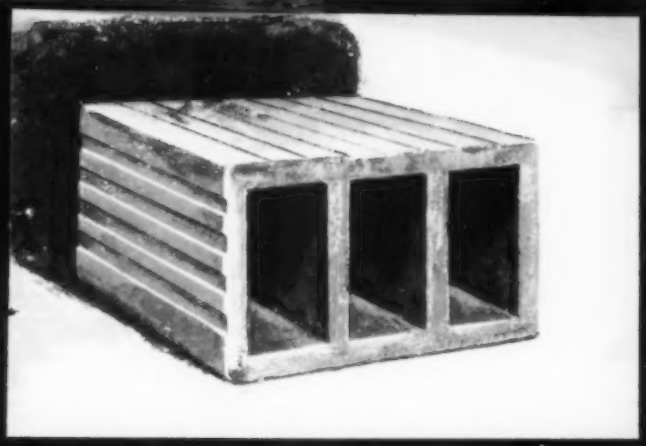
Position _____

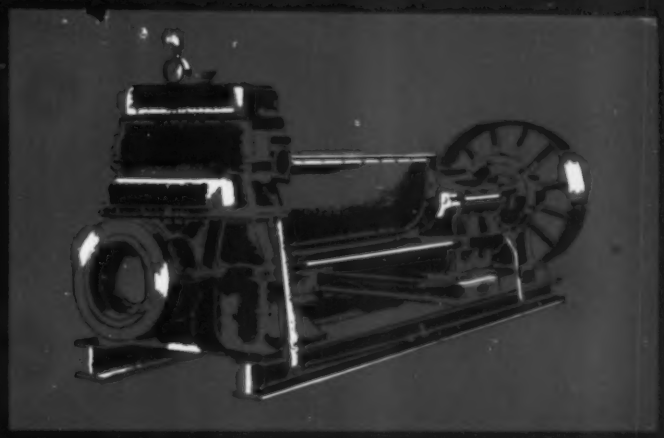
Company _____

Address _____

City & State _____ 3-57

Requests for information made through *Product Engineering* Reader's Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.





No Margin for Air– No Margin for Error

ANOTHER DRIVE REQUIREMENT MEETS ITS MASTER

Yes, it's a fact—unless you remove the air from the clay, you get a no-good tile. And whether air is your problem, or not—error is always a problem. And it's never a mistake to come to Master for the right power drive. In every kind of industry, Master customized package drives give you the utmost in flexibility, compactness and performance.

Here, the primary requirement is power—and the husky, big 200 H.P. Master fills the bill year in and year out. Your requirements might be better met by integrating Master components into a single, efficient, compact unit for the right horsepower, right shaft speed and right mounting features. What are they?

A husky 200 H.P., 440 volt squirrel cage induction Master Motor powers this 14-ton De-Airing Brick and Tile Machine with a capacity of over 8000 bricks per hour. Two parallel shafts carrying pug knives work clay, pass it into vacuum chamber with auger cylinders where it is finished and discharged.

Motor Ratings	⅛ to 400 H.P. All phases, voltages and frequencies.
Motor Types	Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.
Construction	Open, enclosed, splashproof, fan-cooled, explosion-proof, special purpose.
Speeds	Single-speed, multi-speed, and variable speed.
Installation	Horizontal and vertical, with or without flanges and other features.
Power Drive Features	Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

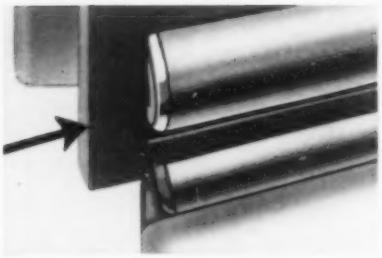
MASTER

THE MASTER ELECTRIC COMPANY

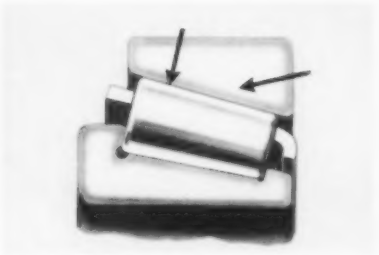
DAYTON 1, OHIO

Get all these advantages . . .
specify TIMKEN® tapered roller bearings

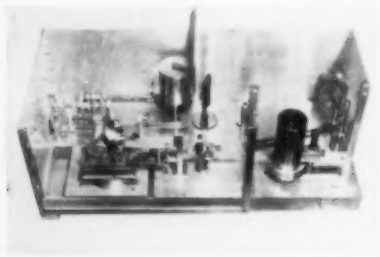
THERE ARE 27 TYPES of Timken® tapered roller bearings. This wide selection means you get the bearing design exactly suited to your job. Whatever your bearing application problem, we can help solve it.



THE SOFT STEEL CAGE used in Timken tapered roller bearings separates the rollers, keeping them spaced evenly. This prevents scuffing of the rollers, adds to the bearing life and gives you more for your money.

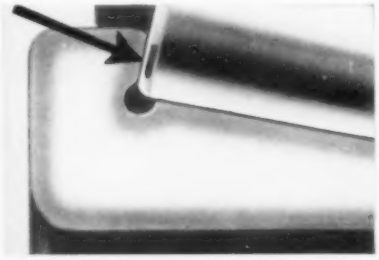


HARD ON THE OUTSIDE, tough on the inside. To take shock loads, give longer life, Timken bearing rollers and races are case-carburized to have a hard, wear-resistant surface over a tough, shock-resistant core.



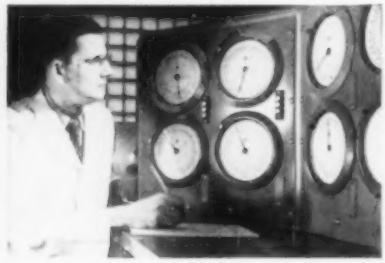
MICRO-INCH FINISH is standard for Timken bearings. This profilograph checks contours and smoothness of circular surfaces to a millionth of an inch, helps us make Timken bearings truer, quieter, longer-wearing.

6,525 SIZES, the world's largest selection of tapered roller bearings. From bearings smaller than your finger to 71½" in inside diameter, the Timken Company can supply the size you need for any specific application.

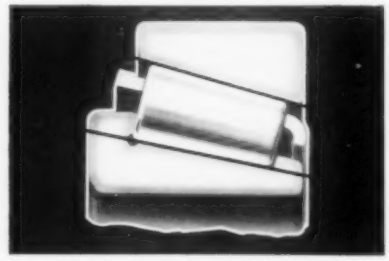


POSITIVE ROLLER ALIGNMENT is assured because the taper in Timken bearings holds ends of rollers snug against the rib. The taper in Timken bearings lets them take radial or thrust loads or any combination.

ACCURATE TO 50 MILLIONTHS of an inch. This Universal Measuring Machine checks gages and machine parts used to make Timken bearings. Our gage laboratory, one of the world's best equipped, helps make Timken tapered roller bearings your No. 1 bearing value.



WE MAKE OUR OWN FINE ALLOY STEEL. No other American bearing maker does. This spectrometer helps control steel quality—in 40 seconds gives the exact chemical analysis of a melt. In a few minutes, results are flashed to the melter. It's another step in rigid quality control.



FULL LINE OF CONTACT between Timken bearings' rollers and races gives them *extra* load-carrying capacity. To get *all* these advantages, specify "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.